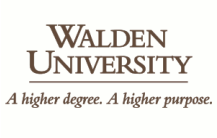

2017

Three Factors Leading to the Failure of Communications in Emergency Situations

James E. Burroughs
Walden University

Walden University

College of Social and Behavioral Sciences

This is to certify that the doctoral dissertation by

James Burroughs

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Mary Brown, Committee Chairperson,
Public Policy and Administration Faculty

Dr. David Milen, Committee Member,
Public Policy and Administration Faculty

Dr. Tanya Settles, University Reviewer,
Public Policy and Administration Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
2017

Abstract

Three Factors Leading to Failed

Communications in Emergency Situations

by

James E. Burroughs

MBA, Florida Institute of Technology, 2011

BS, Thomas Edison State University, 2008

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Policy

Walden University

May 2017

Abstract

The failure of communications, particularly related to interoperability, between police and firefighters responding to dangerous situations has resulted in death or injury to themselves or those they strive to protect. Using Grebner's and Shannon and Weaver's conceptualizations of communications theory as the foundation, the purpose of this general qualitative study was to evaluate, from the perspective of first responders, what barriers exist that may impede opportunities for interoperability of communications systems. Data were collected through semi-structured interviews with a purposive sample of 18 experienced first responders from the states of California, New York, and Texas. Interview data were deductively coded and subjected to a thematic analysis procedure. Key findings indicated that participants perceived differences in technology among agencies as a primary source of frustration and impediment to full interoperability. Further, participants identified policy barriers, a lack of inter-agency training opportunities, and budgetary constraints as frustrating the efforts toward interoperability. The positive social change implications of this study include recommendations to policy makers and first responder agency leadership to support policy change, including appropriations, that encourage increased interoperability among first responder agencies to foster a more expeditious response to large scale emergencies.

Three Factors Leading to Failed Communications in Emergency Situations

by

James E. Burroughs

MBA, Florida Institute of Technology, 2011

BS, Thomas Edison State University, 2008

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Policy

Walden University

May 2017

Dedication

This dissertation is dedicated to my parents who supported my life-long learning goals and inspiration to achieve this terminal degree. Their years of encouragement helped me to continue my dreams despite personal and professional challenges. Thank you, mom and dad, for always being there.

Acknowledgments

I would like to extend acknowledgement and gratitude to my dissertation chair, Dr. Mary Brown, who provided tireless leadership and guidance throughout my dissertation journey. Additionally, I would like to extend a deep appreciation to my second committee member, Dr. David Milen, who supported my endeavors and worked hard to bring my goals to fruition. Finally, I'd like to acknowledge the assistance and support from Dr. Tanya Settles, my URR committee member, for her assistance in my journey.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction to the Study

Somewhere in the United States, a catastrophe is beginning, a conflagration or some other disaster is about to take place, or an accident is about to occur that will require the efforts of emergency response personnel, both at the scene and in back-up support locations. Whether man-made or natural, emergency situations occur continually. At that point, the ability of emergency organizations and personnel to respond quickly and effectively to any such calamity should ultimately bring the emergency to a complete and successful close as quickly as possible. Still, not every emergency has a successful outcome. According to the National Institute for Occupational Safety and Health (NIOSH), an average of 97 firefighters and 155 police officers died each year between 1990 and 2001 ([NIOSH], 2015) in responding to work-related duties. Bringing these statistics more current, roughly 100 firefighters and 85 law enforcement officers perish on the job annually (NIOSH, 2015).

A direct example of these statistics was demonstrated in the fire storm that swept across the American Northwest during the summer of 2015. The National Aeronautics and Space Administration (NASA; 2015) reported that wildfires are growing in intensity throughout the West. At the time, there were almost 30 active fires in Washington State alone. In this situation, the emergency responders were not adequately prepared or properly equipped to confront the challenges faced. The principal challenges included both the lack of radio interoperability and a lack of training with the equipment (NASA, 2015). While this particular condition concerns the equipment, the depth of the issue is further aligned with internal factors such as policy, training, and budget concerns.

The largest fire that was still active as of August 26, 2015 was the Okanogan Complex Fire that not only had destroyed 256,567 acres of land but also had 1,250 people trying to get it under control (NASA, 2015). It started from a strike of lightning and had only been 10% contained 11 days later. The federal government rapidly got emergency funding and other resources to Washington; however, the state topped the casualty list for the summer wildfires with three deaths on August 19 in the Okanogan Complex Fire (NASA, 2015).

In the case of strike teams whose members come from outside the local area to respond to a disaster, as was true in the aforementioned wildfire across the Northwest, a team works off one radio frequency that is usually not compatible with that of other teams. One or two members of the team are assigned to area responsibility and for checking in at the command post where the responsible party might have been issued a radio. Problems arise for numerous reasons: sometimes the number of the command post is not known, other times there could also be environmental considerations that affect the ability to communicate including dense tree cover; whether it is day or night; weather conditions; radio waves reacting differently depending on land, sea, or mountain topography; smoke conditions; and the ability of the communication equipment itself to receive signals (Nowell & Steelman, 2015). All these obstacles affect the ability to communicate over a network.

There is no liaison or policy in place with how the communication will flow via radio frequency or a plan of checking in, for instance, or get on a certain channel unless it is predesignated. When agencies bring in so many resources hastily or the preparation is

not worked out in briefings or memoranda of understanding or agreement (MOUs/MOAs), communication missteps occur. If agencies cannot coordinate their efforts due to lack of communication, the consequences can be life threatening (e.g., in the case of the northwest wildfire, first responders did not even know the fire was headed toward them. They did not know the wind had shifted because they were not familiar with the lay of the land (Nowell & Steelman, 2015).

In the case reported, as in many others, the responders were not adequately or properly equipped to confront the challenges with which they were faced (Nowell & Steelman, 2015). The principal challenges most often include the lack of radio interoperability and other forms of communication. Such a situation is common as a consequence of the lack of essential and regularly-updated training programs, inadequate and improperly allocated budgets, and ineffectual or misapplied governing policies (Timmons, 2007).

The topic of the present study is communication during a crisis, an especially important issue for first responders to disasters including wild fires, terrorism, and acts of nature where significant numbers of people are involved. From the perspective of public policy makers, the three most important elements of such communications interoperability are adequate resources (budget), up-to-date and functional equipment and how to use it (training), and policies to expand radio interoperability and communication among first responders (policy). Although radio interoperability specifically and communication in general are paramount in emergency management, few scholarly studies have been conducted in this area. Understanding the implications of the lack of

communication interoperability and its connection to budget, training, and policy has important social ramifications in emergency management. In this chapter, I give background for the development of communications interoperability and present the conceptual framework of communication theory of the study as well as the research questions, operational definitions, and qualitative methods.

Background of the Study

Clear, uninterrupted communication is essential in the field of emergency management where firefighters and law enforcement rely heavily on radio interoperability. When multiple agencies are involved in a major event like a wildfire, frequently, emergency personnel cannot communicate with one other (Barthel, 2012). At best, they can do so on a very limited basis, for the bandwidth is too small. Consequently, firefighters and law enforcement personnel who work the same incident often resort to using personal cell phones and social media as a fast and reliable way to communicate the events, the course of action, and the outcome of the situation (Brengarth & Mujkic, 2016; Tuite, 2012).

Different organizations have different means of communication. These agencies can be paid or volunteer fire departments or law enforcement entities including urban police departments; sheriff departments; regional FBI; and federal agencies at the federal, state, county, and local town or city level among others (Kehl et al., 2014). Regarding budget and policy issues, larger organizations have more funding compared to smaller agencies and a variety of policies (Kehl et al., 2014). These variations depend on budget and training of persons within a particular agency. Additionally, each organization has

different policies regarding the use of the equipment for radio interoperability and might have MOUs) and MOAs between two organizations to (a) work off same channel and (b) follow procedures if an incident happens when calling in mutual aid (Timmons, 2007). Resource allocation policies are regulated by budget or sometimes military standards related to weather conditions (NASA, 2015). Often mutual aid does not work. Even if on different frequencies, responders can patch/manipulate frequencies but problems arise if they do not support large-scale incidents like the floods in New Orleans (Davis & Robbin, 2015). These differences create the issues of lack of consistency and interoperability. While there is a particular channel within the radio system that allows firefighters and law enforcement personnel to interact simultaneously, this system is not always reliable when the integrity of the bandwidth becomes compromised (Timmons, 2007).

Moreover, one-on-one communication can occur through one person being *patched* to another person's radio. This is effective for updates, procedures, and course of actions, but this approach is not effective, for the communication is limited and then must be communicated with others, which costs time and potentially the lives of the first responders and those they are trying to save (Barthel, 2012). Compounding these problems are the elements of training and budget. Specifically, different municipalities have different allocations of budget for the actual equipment (Barthel, 2012). Another problem is that of firefighters and law enforcement personnel who need training on the actual equipment (Barthel, 2012). Because the actual equipment is different in each organization, the training is also different. Additionally, the training is not necessarily

standardized, so what and even who conducts or disseminates the information on the given equipment is not uniform. Public policies are needed to address the lack of communications interoperability because in these events, in essence, it is a matter of money and training versus saving lives. Although the literature on emergency management addresses communication issues in disasters (Brito, 2007; Hutchins & Timmons, 2007; Kawasaki, Berman, & Guan, 2013), no previous literature has been found on the lack of interoperability between firefighters and law enforcement personnel who resort to using personal (or work) cell phones as a way to mitigate a situation.

There is a need to complete this study to increase the efficiency of communication between both the firefighters and those in law enforcement. This study also has the potential to result in policies that can save the lives of those who require assistance of firefighters and law enforcement personnel in a given situation. Furthermore, this study examines current practice that can lead to recommendations on how to better improve policy and practice within the discipline of emergency management.

Problem Statement

Lack of communication interoperability is becoming more significant in the field of emergency management. This field has grown exponentially due to natural disasters, acts of terrorism, and home-grown issues such as budget cuts, personnel reductions-in-force, and increased technological needs in a given community. Consequently, seeking to ensure reliable communications interoperability in emergency management organizations such as the Federal Emergency Management Agency (FEMA) can pose multidimensional challenges for first responders in crises (FEMA, 2009; Minnis, 2013). Without effective,

reliable communication and its connection to public policy, the lives of first responders and those they rescue are placed in jeopardy. In challenging ineffective policies, thorough reviews of current standards, congressional law, situational investigations, executive orders, and committee reports have indicated inconsistencies in policy, training, and budget (Minnis, 2013).

The gap in the literature is in scholarly studies on lack of communications interoperability during mass human crises and climate disasters including drought, flooding, wildfires, and winter storms (National Centers for Environmental Information, 2016). Most reports originate from government sources and government agencies (e.g., the Centers for Disease Management and Control; CDC). Many peer-reviewed studies have been conducted regarding mass medical emergencies and event preparedness and recovery (e.g., Holmberg, 2014; Klappa, Audette, & Do, 2014; Yang, Xiao, Cheng, Zhu, & Arbon, 2010). This study addresses the substantive aspects of training, budget, and policy and how these three elements are inextricably linked to the provision of secure and reliable communication interoperability during grave emergencies. Perhaps a study such as this that investigates first responders' experiences involving lack of communications interoperability and its connection to training, budget, and policy could help to mitigate life-threatening situations.

Purpose of the Study

The purpose of this basic qualitative study is to explore reliable means and measures to effectively ensure the safety of emergency responders through reliance on totally dependable radio communications (either directly or via a network), based on the

premise that reliable radio communications and fail-safe communications interoperability depend, in the context of this study, on three essential constituents: training, budget, and policy. For this study, I employed a qualitative research method. The data researchers derive who prefer a qualitative approach contain rich descriptions of social constructs as perceived by the participants (Wahyuni, 2012). In carrying out the research of this study, the effort entailed conducting interviews with law enforcement personnel and firefighters from the states of New York, Texas, and California. These individuals had been involved in emergency situations that had taken place in those states. Thus, I was able obtain first-hand depictions of the kinds of adversities with which they were faced in addressing or surmounting a condition of failed communications interoperability in emergency situations. I also explored the role of policy, training, and budget in connection with communications interoperability.

Research Questions

This study centered on and was guided by two essential questions:

1. How do first responders describe their experiences in emergency situations that involve lack of communication interoperability?
2. What is the role of budget and training in connection with communication interoperability and the policies that might be instituted to improve the safety of emergency responders?

Conceptual Framework

The conceptual framework of my study is based on three theories: Grebner's general model of communication theory; Shannon and Weaver's information theory; and risk communication theory.

Grebner's Model of Communication Theory

Grebner (1956) developed a communication theory model that emphasizes not only its dynamism but also how its reliability is affected by a variety of factors. To this end, communication is only dynamic and effective if there is a consistent method for how it is used. The factors in play in the perceptual dimension during an event (E) regarding the message (M) are selection, context, and availability (Grebner, 1956). In this dimension, where humans cannot perceive the entire event, they select what is needed or what interests them, leaving out the rest of the context of the event and the availability involves different cultural and personality factors (Grebner, 1956). In the means and controls dimension, humans now have to communicate with a third party and create context around the message to communicate in a variety of ways. They have varying degrees of control over the message at this point depending on their capabilities complicated by different receivers with many ways to perceive the message and interpret it (Grebner, 1956). The important concept is that at every level, communication can be changed or altered (Grebner, 1956).

Shannon and Weaver's Communication Theory

Shannon initially began working on communication theory in the late 1940s to solve "the technical problems of high-fidelity transfer of sound" (Griffen, 2014, p. 48)

and collaborated later with Weaver, who was more interested in the interpretation of human communication to demonstrate that reducing loss of information regarding any communication issues solved the problem. Although the theory is based on the simple process of transferring messages from the one who encodes (i.e., the speaker) to one who receives (i.e. the listener), the strength of the message can be obscured through what is referred to in the theory as *noise* (Griffen, 2014). Noise can disrupt the flow of communication so that the receiver might not receive the intended message (Griffen, 2014).

Risk Communication Theory

Finally, risk communication theory has some of its foundation in Fischhoff's (1995) work regarding how managers should communicate a risk-like situation to the public. However, this definition has expanded over time and is now being applied to anyone in emergency management who becomes responsible for risk control. Risk communication has a tradition of focusing on information presentation, persuasion, and strategic messaging (Coombs, 2012). Additionally, failures at controlling or managing risk effectively can lead to a crisis, or a crisis may lead to the necessity for risk communication (Coombs, 2012).

Application of Theories to Lack of Communication Interoperability

All three theories are applicable to the conceptual framework of the present study, for it involves communications interoperability or its lack based on training, budget, and equipment stemming from public policies. First, communication is only dynamic and effective if there is a consistent method in how it is used. With this concept comes the

need for all law enforcement agencies and firefighting stations to have policies in place to facilitate channels within communication media for emergency personnel to be able to communicate with one another. Having the physical ability to communicate with other first responders is vital to mitigate an emergency situation. However, there are additional factors such as having the equipment but not knowing how to use it or human skill degrees in using the channels of communication (Grebner, 1956). These factors have a direct impact on first responders needing appropriate training. Further, the equipment and training may never even be issues to consider if adequate funding, proper budgetary items, are not initially allocated to provide first responders with the life-saving tools to complete a task.

Second, regarding information theory in the present study (Griffen, 2014), the communication problem involves not being able to communicate, which may lead to loss of lives of both first responders and those of whom they are tasked to save. The factor of noise, in which the intended message is distorted or lost due to factors such as the disparate channels and protocols of communication among different teams, is significant in lack of communication interoperability (Griffen, 2014). Last, in lending itself specifically to first responders and their ability to manage the risks they encounter, risk communication theory is a solid part of the conceptual framework. The media of these first responders for successfully being able to resolve the risk are dependent on communication. The communication itself is dependent on several factors: having the budget to provide for the equipment, being able to support the responders in terms of training, and having equitable equipment and opportunity for all responders to

communicate on the same radio frequency (Griffen, 2014). Further elaboration on connections of the three theories in the conceptual framework can be found in Chapter 2.

Nature of the Study

In the context of this basic qualitative study, I conducted a series of semistructured interviews, using open-ended questions in the examination of particular events or occurrences to understand the attendant factors which may have had an influence on the experience of the interviewees. There were six participants from each state including one firefighter and one law enforcement official from an agency that serves a large population, one of each from a small agency such as a volunteer firefighting agency or law enforcement agency of fewer than 25 sworn personnel, and one of each from a rural agency with a large land base and small population (Oliver & Meier, 2016). Thus, there were a total of 18 participants. I sent a detailed letter to get approval from organizational leaders of several firefighting and law enforcement organizations to recruit participants who have experienced lack of communications interoperability.

I selected the two different organizations simply because there is a high prevalence in both disciplines when it comes to lack of radio interoperability. Wildfires, for example, involve first responders from law enforcement as well as firefighting. It is also known that this issue has a trickle-down effect on other public safety disciplines such as EMS and emergency management to include public works and other public services that have numerous incidents of communication difficulty (Zane et al., 2012). The problem has also been seen in both organizations from the rural to the urban context via

policy issues, equipment disparities, and budget problems for getting better resources (Comfort, 2012). Both agencies work together as first responders in disaster scenarios. Yet, even autonomously, agencies have issues talking to each other and outside jurisdictions (Comfort, 2012). Personnel do not want to give up codes and all are encrypted, which is why they can no longer receive communications on scanners (Comfort, 2012). All these breakdowns in communication interoperability can result in serious consequences for first responders and those they are entrusted to serve.

In finding the best method to conduct my study, I reviewed various methodological traditions. Wahyuni (2012) noted that quantitative research revolves around statistical data from an objective point of view. Quantitative researchers use instruments that are predetermined so that they can test hypotheses or seek correlations between variables, and in a mixed methods study both qualitative and quantitative data are used (Wahyuni, 2012). Because I did not plan to develop hypotheses or find relationships but rather explore and attempt to understand people's experiences, neither quantitative nor mixed methodologies were appropriate.

According to Yin (2014), qualitative research methodologies are used to collect rich experiential data through interviews, document review, and observations. Such data are not numeric but instead can be presented as narrative. Qualitative research is used to understand more deeply people's social motivations. Its data result in word instead of numerical data (McCusker & Gunaydin, 2015). Additionally, it is used to explore people's experiences in their natural settings at the same time the researcher strives to uphold ethical principles (Damianakis & Woodford, 2012).

Types of qualitative methodology include basic qualitative study, case study, phenomenology, ethnography, narrative inquiry, and grounded theory. The type of qualitative research I conducted was a basic qualitative study, which Merriam and Tisdell (2015) reported was conducted in studies resulting in peer-reviewed articles that researchers in many fields have presented. In the mental health field, for instance, Fernandez, Breen, and Simpson (2014) conducted basic qualitative research on women with bipolar disorders and ways in which their identity and loss had to be renegotiated (as cited in Merriam & Tisdell, 2015). The present study most lent itself to such a design to conduct a detailed exploration of the participants' experiences regarding communications interoperability during crises.

Phenomenology involves obtaining and understanding real experiences through which the participants lived, and the present study was derived solely through interviews through which rich, in-depth data were obtained (Denzin, 2012). Although I originally intended the study to be phenomenological, the data collected from 18 different participants, though abundant, did not necessarily go into such depth. Both grounded theory and narrative inquiry are used to develop "theories about psychological and social process" (Lal, Suto, & Ungar, 2012, p. 6). While my study on first responders' experiences with lack of communications interoperability involved such processes, three communication theories, already developed and discussed, formed the framework of the study. No framework had to be developed in the study. A case study is used by researchers to explore events, bounded programs, or activities from the perspective of participants (Yin, 2014).

Participants in this study were interviewed individually on their first responder experiences at the height of responding to disasters and what led up to lack of communications interoperability rather than perspectives on such events in general. Finally, ethnographers tend to study people as groups in their natural backgrounds over long periods (Petty, Thomson, & Stew, 2012). They also observe organizational culture closely and how the participants function in that culture (Peterson & Sondergaard, 2011). Interviews lasted approximately 30 minutes to 1 hour; thus, they did not take place over prolonged periods and require embedded with the groups or observations. Therefore, ethnography would not have been an appropriate form of qualitative research for the study.

Definitions

The following terms are used in this paper or in documents referred to in this paper:

Communications interoperability: In this context, the capability of a public safety agency to communicate by radio (either directly or via a network) with another public safety agency, on demand (planned and/or unplanned) and in real time (Hawkins, 2013). The radio link may be classified as either infrastructure independent or infrastructure dependent (Hawkins, 2013).

Communications plan: Formal and agreed-upon strategies for communicating project status and activities to key stakeholders and methods for developing historical project records and archives (Hawkins, 2013).

Frequency bands: Frequency bands where land mobile radio systems operate in the United States, including the following: High HF (25-29.99 MHz), Low VHF (30-50 MHz), High VHF (150-174 MHz), Low UHF (450-470 MHz), UHF TV Sharing (470-512 MHz), 700 MHz (764-776/794-806 MHz), and 800 MHz (806-869 MHz) (National Task Force on Interoperability Guide, 2005).

Incident Area Network (IAN): A basic communications networking type used to describe voice and/or data networks used by public safety agencies for emergency incidents or events (Hawkins, 2013). An IAN is a single network, or set of networks, providing communications for responders across the entire organization and geographic scope of an incident or event (Hawkins, 2013).

Incident Command System (ICS): An organizational management system adapted from military techniques for public safety emergency response (National Task Force on Interoperability Guide, 2005). It provides common terminology, modular organizational structures, and objectives-based management principles among its basic principles.

Infrastructure: When relating to radio communications systems, the hardware and software needed to complete and maintain the system (National Task Force on Interoperability Guide, 2005).

Patch: A control center subsystem that permits a mobile or portable radio on one channel to communicate with one or more radios on a different channel through a control center console (National Task Force on Interoperability Guide, 2005).

Protocol: A set of unique rules specifying a sequence of actions necessary to perform a communications function (National Task Force on Interoperability Guide, 2005).

Shared channels: One of several means of achieving technical interoperability in which cooperating agencies designate specific, often dedicated, radio channels for interagency use (Department of Homeland Security; DHS, 2008). Most public safety radio bands have designated shared frequencies that are often used, though the term applies generally to any channels adopted for interagency communications (DHS, 2008).

Shared system: A communications system developed by two or more different entities (e.g., local and state law enforcement agencies) to share the effort of system development, maintenance, and operations. Benefits of shared systems include lower costs, widespread interoperability, community interaction, and shared management and control (National Task Force on Interoperability Guide, 2005).

Assumptions

The central assumption of this dissertation was that the elements of sound, multidisciplined training of all personnel involved with the quelling of emergency situations play key roles in fostering and promulgating effective radio interoperability. Such interoperability must support those who bear the responsibility of saving property, reducing injuries, and saving lives in all types of emergency situations, natural disasters, and other crises. A further assumption is that the interviewees, whose level of involvement in this study is outlined in Chapter 3, would be forthcoming with their answers and that such interviews would generate genuine and accurately recollected

responses, which also applies to the case studies of real events which are examined for further data.

Scope and Delimitations

The central aspects of the research problem involve training, budget, and policy to address the issues of lack of interoperability. In this basic qualitative study, specific aspects of the research problem were explored through the lived experiences of the participants. A broader view of these three elements of lack of interoperability that these first responders experienced would involve the following needs: (a) training for first responders, transportation personnel, central station staff and management in the use of assigned radio and mechanical equipment and weaponry for various forms of emergencies and life-threatening crises; (b) local, regional, and federal funding authorities collaborating with related authorities in researching and developing an understanding of the costs and proper usage of essential and practicable equipment needed to support addressing various crises as they arise; and (c) state-wide and regional emergency policies via governance and operational policies for addressing various forms of crises.

The participants in this study were only first responders from the law enforcement and firefighting fields who have been involved in emergency situations in California, New York, and Texas. Excluded populations from this field were first responders like EMTs, nurses, and physicians based in medical centers and hospitals. However, data from the present study had potential transferability to other fields in which first responders are employed or volunteer. Other theories related to communication could

have formed the conceptual framework. Still, Grebner's (1956) general model of communication theory; Shannon and Weaver's (1963) information theory; and risk communication theory fit the purpose, to explore the perceptions of emergency first responders on issues of lack of interoperability, the understanding of which might depend on the three essential constituents of training, budget, and policy the best.

Limitations

One limitation of the study is that the research was confined to two branches of emergency responders: law enforcement and firefighting. Another limitation is the participants were chosen from only three predetermined states. There are 47 other U.S. states from which to choose, yet that limitation was addressed by a wide geographical range: the East, the South, and the West Coast. A third limitation is that the sample group was relatively small, and consisted of only 18 first responders with at least 10 years' experience responding to emergency situations in their respective states. The results from this basic qualitative study could not be generalized to all first responders in all states who have experienced emergencies of disastrous proportions.

Significance of the Study

The continued inability of responders, agencies and governmental departments to communicate and coordinate their responses to emergency situations can lead to injury and, too often, the devastating loss of lives as was reported in the Okanogan Complex Fire in August 2015 (Nowell & Steelman, 2015). To illustrate, one need only look at the World Trade Center terrorist attacks. The lack of interoperability between police and fire radios was a prime factor in the deaths of at least 121 firefighters (Stack, 2015). The

Katrina hurricane disaster and the Virginia Tech shootings also illustrate the importance of communications interoperability and cross-agency collaboration (Verkuil & Fountain, 2014). More recently still are the wildfires that swept the Northwest. Wildfires have been the most common, widespread disaster involving communication interoperability (Insinna, 2013).

Scientists have reported that global warming trends have increased wildfires more than cyclical droughts because the more recent warming trends deprive forests of moisture, making them more vulnerable to fires when they do occur (Graham, 2015). Because the high temperatures have decreased the snowpack, the fires can reach higher altitudes (Graham, 2015). Furthermore, because the fires have spread into more remote areas than in the past and personnel have come from faraway places with different levels of training and equipment, lack of communication interoperability has increased to the point that more lives are being lost in spite of best efforts to cooperate in fighting fires (Graham, 2015).

Whereas there have been many reviews concerning major disasters, such as the terrorist attacks of 9/11 or Hurricane Katrina, the significance of this dissertation is its attention to localized emergency situations, with its focus on three regions of the country to demonstrate how the lack of radio interoperability, despite the size of the populace and geographical location, continues to be an issue for emergency responders. Moreover, this study examined the lack of radio interoperability as it correlates with the specific issues of training, budget, and policy, with the intent of developing advancements in those areas

of concern which can lead, ultimately, to increased safety and security for firefighters and police officers on the job.

If the objectives of this study are fulfilled, then its significance to society and to those called upon to respond to emergency situations becomes manifest in positive social change. If, through research and relevant in-depth analysis, viable conclusions can be drawn and meaningful directions leading to an achieved 100% interoperability of radio communications in crisis situations can be posited, then the tragic consequences of avoidable death and injury in emergency situations can be averted and the study will have endowed a valuable service to society.

Summary and Transition

In this introductory chapter, I have presented the problem of lack of communication for first responders involved in catastrophic events. Few scholarly studies have been conducted on this issue, particularly regarding radio interoperability; therefore, the study can fill a gap in the literature and contribute to positive social change in society when public policy as well as training and the money help to ensure seamless communications interoperability to prevent personal injury and loss of lives. The purpose of this basic qualitative study was to explore ways to increase safety for emergency responders through understanding their lived experiences regarding lack of communications interoperability in helping to mitigate natural and human-made disasters. The research questions were directed to efforts for ensuring the sustainment of interoperability; federal, state, and local policies to improve their safety; and an exploration of the roles that training and budget would play in connection to the issues.

Chapter 2 presents an exhaustive search of the literature in the field of emergency management and shows a significant gap in scholarly studies, specifically on lack of communications interoperability. Chapter 3 outlines the steps that will be followed to conduct a basic qualitative study of first responders' experiences with lack of communication interoperability during a disaster. In Chapter 4, I present the findings from the interviews of first responders and in Chapter 5, I analyze the findings and present my conclusions and recommendations for further research on lack of communication interoperability it is relates to budget, training, and public policy.

Chapter 2: Literature Review

Communications interoperability, particularly when it is based on radio interoperability, involves two people or more in communication over wireless equipment (Timmons, 2007). However, often during a disaster, communication is far from adequate (Timmons, 2006). Timmons (2006) named various issues that could impede communications interoperability: poor infrastructure, human stress reactions, inadequate training and procedures, and lack of policies that would diverge from routines and operate well. With due reference to a range of articles corresponding to those themes, Chapter 2 includes excerpts taken from the literature, which correspond to and support the problem statement of this study that points to the tripartite elements of training, budget, and policy as being fundamental elements in securing reliable communications interoperability in all emergency situations and crises.

The general problem is the growing significance of lack of communication interoperability in the emergency management field, which has increased in importance due to growing natural disasters and human-based acts of terror. More specific are the challenges that emergency managers face in insuring severe challenges for first responders during particular crises and the roles that policy, budget, and training play in having good radio interoperability or in its lack that can lead to injury or loss of lives. In addressing these issues, reviews of ineffective policies at the federal, state, and local levels have indicated inconsistent budgets and training for first responders (Minnis, 2013). In a thorough review of the literature, there appears to be a gap in scholarly

research on lack of communications interoperability during natural disasters and human crises.

The purpose of this basic qualitative study is to explore how first responders in fire safety and law enforcement respond to how they attempt to ensure their safety by relying on direct or network communication interoperability based on the premise that reliable radio communications and fail-safe communications interoperability depend, in the context of this study, on the important constituents of budget, training, and policy. Chapter 2 contains an introduction that includes a restatement of the problem and purpose of the study, a preview of the sections that constitute the literature review, the strategies used for searching the literature, a discussion of the three-pronged conceptual framework, sections that review literature on communications interoperability and how the roles of budget, policy, and training for first responders are related to lack of communications interoperability, a summary of the chapter, and conclusions.

Literature Search Strategy

I explored the topic of lack of communications interoperability through various primary sources including scholarly articles, government documents, published articles geared toward emergency management, Department of Homeland Security (DHS) publications, and web information reporting statistics on disasters, and books on emergency management and qualitative research. The primary source used was Walden's online library in addition to other online databases such as ProQuest, Academic Search Complete, and Ebsco. Although I attempted to use mostly peer-reviewed articles from 2012 up, much of the pertinent policy information came from government sources

involving security and statistics that were especially prevalent in the years after the 911 attacks on the homeland. Search terms and descriptors included yet were not limited entirely to the following: *communication during disasters, communication theories, disaster management, emergency management, emergency equipment, emergency training, lack of communication* or *radio interoperability*, and *public disaster policy*. The literature review is presented with the following headings: theoretical foundation, literature and related literature, a synthesis of literature, a summary, and conclusion.

Conceptual Framework

The three theories that form the basis of the present study are Grebner's general model of communication theory, Shannon and Weaver's model on communication theory, and risk communication theory. Grebner's (1956) model was a foundational theory not only for understanding the depth of basic communication but as it was developed further over decades, it was also applied to mass communication (McQuail, 2010). In this seminal work, Grebner argued that the challenge in the field of communication was not having any in-depth understanding of its context, for communication lacked a framework to discuss technicalities. Not only did the field at the time lack the aforementioned understanding but also missing was a way to make sense of findings that were needed for "urgently needed judgments" (Grebner, 1956, p. 171). The steps in Grebner's graphic model construction are a good fit for the present study because the model specifically involves a fire. Expanding the first step (someone), can be multiple team of first responders who respond by gathering to fight a wildfire (Steps 2, 3, 4) and attempt to communicate through radio (Steps 5, 6, 7) in the context and conveying the

content in ideal communications interoperability (Steps 8, 9) with consequential saving of lives. However, when there is a lack of communication interoperability, particularly via radio equipment, due to various issues including policies, budget, and training, the consequence may be loss of lives of first responders and the individuals they are tasked to rescue.

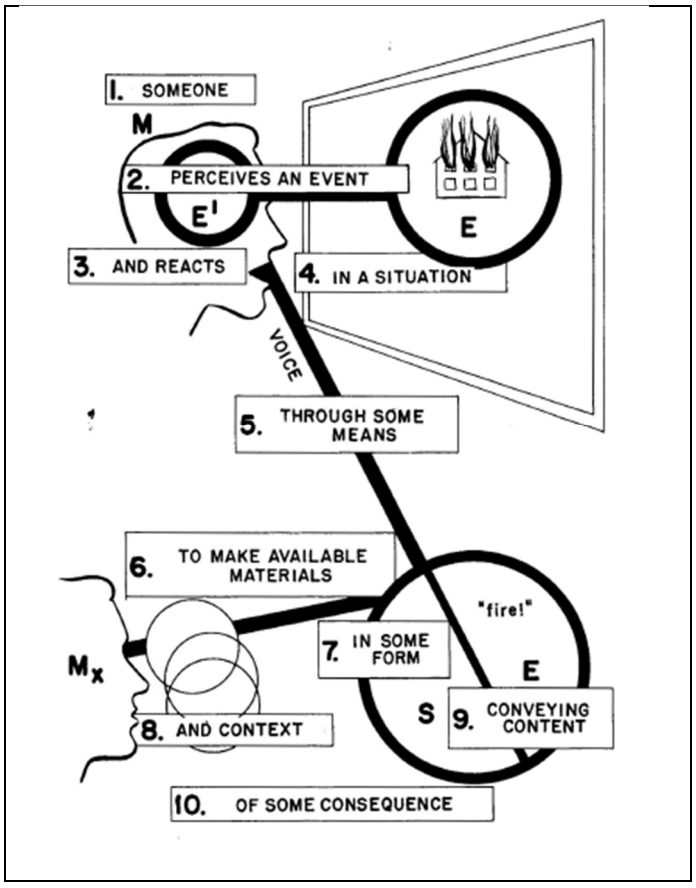

Figure 1. Steps in the construction of a graphic model. *Note*. From G. Grebner, "Toward a General Model of Communication." *Audio-Visual Communication Review*, 1956, Vol. 4, No. 3, p. 175.

Shannon's (1948) model on community theory was a seminal work often used by information systems personnel as a basis for systems involving group communication (McEntire, 2007), which is also the foundation of the present study, which involves groups of emergency management people. Weaver and Shannon (1963) believed that information reduces uncertainty (McEntire, 2007); however, McEntire (2007) claimed that being able to decide on a clear meaning of information is something that continues to elude researchers and that information communicated gets overcomplicated or oversimplified as fundamental as it is to all communication fields: "Information may be described as a representation of a message that is processed into something valuable so that it may be applied in a practical context" (p. 296). Clear communication can be elusive in a disaster when many groups of people come together under differing policies, training, and resources, which compounds the outcome of such events. Aside from the basic model of Source => Message => Channel => Receiver are the complications individual's experiences in everyday communication as well as during emergencies, also known as the dynamics (McEntire, 2007). The latter involve distortion where the source does not encode the message with all the intention desired, which leads to loss (Changing Minds, 2016). There also is noise, which can be much like a telephone game with people but can be more serious or life threatening when the noise entails communication equipment that leads to lack of communication interoperability (Changing Minds, 2016).

Risk communication theory has emerged as an important directive of DHS. The DHS issued a report on the need to understand risk communication theory (Sheppard, Janoske, & Liu, 2012). The theory is based on Fischhoff (1995), who developed research

on ways that emergency managers communicate to the public on events of considerable risk. As stated previously, the definition of risk communication theory can be applied to any emergency manager who is in charge of risk control, yet if they fail to manage efficiently, either it can lead to a crisis or the crisis may result in hindsight for the necessity of risk communication (Coombs, 2012). Initial efforts to centralize and organize risk communication came from legal and regulatory policies particularly regarding right-to-know that was enforced at federal, state, and local levels (Sheppard et al., 2012). When experts in risk communication worked with the public, it became more important than before to understand processing and acting on communicated messages (Sheppard et al., 2012).

Risk communication theories come into play during the preparedness, response, and recovery phases of a disaster. The response phase is particularly relevant to the study where first responders were interviewed about the challenges they faced when there was lack of communications interoperability during this phase (Sheppard et al., 2012). The strategies, or postures during this phase, according to a subtheory, situational crisis communication theory, are (a) *denial* when an organization tries to back off from the crisis and may include scapegoating; (b) *diminishment* to reduce negative effects, which may include excusing organizational actions; (c) *rebuilding*, in which attempts are made to reduce or justify perceived damage and excuses for organizational behavior; (d) *redeeming*, in which an organization's reputation is attempted to be redeemed; and (e) *bolstering*, in which the other three are supported to improve relations between organization and stakeholders (Sheppard et al., 2012). Grebner's general model of

communication theory, Shannon and Weaver's model on communication theory, and risk communication theory are all related to lack of communications interoperability due to the dependence on good communication for first responders to save lives and property.

Lack of Communication Interoperability

Although much of the research on emergency management communications focuses on the lack of interoperability, few peer reviewed studies in the United States have been carried out on communications at the height of a disaster, whether natural or caused by humans (e.g., wildfires and domestic or foreign terrorist attacks). The devastation of Hurricane Katrina was so significant that the *hurricane* keyword put into the PsycINFO 3 years ago would have resulted in more than 1,400 hits compared to 10 years ago when it resulted in fewer than a dozen (Piotrowski, 2013). Interestingly, the field of disaster studies is now addressed increasingly in the social sciences, and communication interoperability or its absence is highlighted in most studies (Piotrowski, 2013).

Disasters are increasing exponentially because of a changing environment and nonwar terrorist aggression (Sun, Jones, & Nell, 2013). Recently, conversations and policies based on war, terrorism, and other human disasters have become dominant. Under these circumstances, exceptions have been made for constitutional protections, which result in policy restrictions that can stop the flow of communication during a disaster (Sun et al., 2013). These kinds of restrictions, while appropriate in war in the case of intentional opponents, are invoked in disasters that lack thinking opponents. Such exceptionalism of transparency is seen both in policy and rhetoric and transforms public

places into war zones (Sun et al., 2013) from which people (and first responders) can be restricted from essential communication. Sun et al. (2013) argued that using war in nonwar emergencies must be consciously held as separate events. Then emergency personnel can make appropriate determinations on how to communicate in periods of crisis.

An overriding concern in lack of communication interoperability is the sheer number of systems that fail to talk to each other. For example, many issues exist including VHF high-band signals not working inside a structure as well as would UHF 700- and 800-MHz ones (Tuite, 2012). Also involved in the licensed bands are the personal radios for firefighters, all of which can lead to lack of interoperability. Tuite (2012) continued to describe eight open interfaces, yet the major issue is that original technologies start to become obsolete in both bandwidth and capacity when cellular technology takes over. The new technology is known as long-term evolution or LTE, which signals that it is adaptive as innovations continue (Tuite, 2012).

In the field of emergency management, most of the research centers on medical emergency responders and recovery phrases (e.g., Hofmeyer, Scott, & Lagendyk, 2012; Holmberg, 2014; Yang et al., 2010). Various studies done in the field of emergency management as they relate to lack of communication interoperability have been carried out through face to face interviews as were done in the study (e.g., Anthony, Dowden-Dodgson, O'Hair, Heath, & Eosco, 2014; Huyck, 2013; Huyck, 2015; Revere, Calhoun, Baseman, & Oberle, 2015). Explored in this section is research on the historical context of emergency communications, lack of communications and radio interoperability, the

role of technology and social media in disasters, and emergency alternatives to boost interoperability (e.g., balloons, satellites, expanded broadband, mobile units with satellites).

Historical Context

Spectrum allocations for radio were developed in 1912 in the Radio Act (Hazlett & Ohn, 2013). The purpose was to define harmful interference and control it, which led to rationalizing regulations (Hazlett & Ohn, 2013). Hazlett and Ohn (2013) posited that the system does not function well and limits the spectrum while the system itself has been disputing over borders for decades. At the same time, having unclear borders may lead to market development as long as they are bundled in an economically efficient way (Hazlett & Ohn, 2013). Hazlett and Ohn argued that the main components should be flexible and exclusive and frequency borders can be set according to limits involving standardized edge emissions. Instead of attending to exact contours of interference, regulators need to give bandwidth to responsible agents so that unwarranted fragmentation is avoided.

Instances of lack of communication interoperability, even in historical natural and human disasters, are often seen in retrospect and decades after the event. Whether or not to join Allied forces in Europe was in strong debate between isolationists and interventionists (Burtness & Ober, 2013). President Franklin Roosevelt was among the interventionists, and the isolationists saw U.S. involvement as a mistake from which they should have not confronted again after the Great War (Burtness & Ober, 2013). However, despite intelligence reports about Japan's intent to bomb Pearl Harbor, the person

responsible for reading the decrypted reports decided to engage in a personal activity rather than labor over the papers that had been provided to him (Burtness & Ober, 2013). If General Marshall, the said person in charge, had done what he customarily would have done, he would have been able to issue a warning to personnel at Pearl Harbor and prevent the devastating loss of life that was incurred (Burtness & Ober, 2013).

The general's actions were the culmination of many other inactions on the part of military personnel. Although intelligence had been gathered about a sabotage and possible attack on U.S. military operations from Japan, many in the War Department ignored the severity of the situation (Burtness & Ober, 2013). The problem in the present study involves lack of communication interoperability, particularly regarding radio; however, ignoring communication of any kind by emergency managers whether from radio, through intelligence operations, or social media generally results in devastating losses that can be prevented with the preparation that is the end result of competent training, sufficient budgets, and supportive policies. Such is the case thoughout history (Burtness & Ober, 2013).

The need for seamless emergency communications has been apparent from the turn of the 21st century, from which time both natural and human disasters have been increasing rapidly. Barthel (2012) saw the 9/11 attacks on the United States as a "watershed event" (p. 2) that made most Americans aware that they were vulnerable to strikes not only from outside the country but also from individuals who were nonstate actors. As a result, the need to improve security in the homeland was made clear and the responses had to come from local to national levels and from private resources. When

problems arose regarding the responses, highlighted were issues in command, control, and communication areas on all levels (Barthel, 2012). In 2010, the National Security Strategy (NSS) revealed that security of U.S. citizens is of everlasting interest to all (Barthel, 2012). Furthermore, resilience and security are required due to threats both from environmental and terrorist crises (Barthel, 2012).

Radio Interoperability

In most natural and human-caused disasters, communication via radio is the main means, and communication interoperability, or lack thereof, generally involves radio communication. In an early work on interoperability, Timmons (2007) noted that defining radio interoperability is far from simple, but it is used as a universal term for many types of communication. However, divorced from the issues of radio interoperability, one might more broadly define radio interoperability as being the ability of emergency responders to achieve clear, uninterrupted, radio communications, essential in assisting them in their efforts to quell the types of emergency situations to which they have responded (Barthel, 2012). In the same manner, bringing the important matter of interagency communications into the picture, the National Incident Management System (NIMS) revealed that when communications are interoperable, first responders can "communicate within and across agencies and jurisdictions by voice, data, and video" (p. 8). Simply stated, interoperability exists when radio system operators can connect with other radio systems with no problem areas so that emergency responders can communicate in a fast and effective way. Such seamless communication can make the difference between life and death in many cases (Stack, 2015).

The definitions may vary in their wording but not in their essential meaning; they accurately affirm the goal of unrestricted radio interoperability as the ideal. However, as Barthel (2012) argued, various methods of communication have become almost obsolete and include radio/phone patches, liaison use, shared channels, radio swapping, systems that are trunked, and control centers or dispatchers relaying important communications. Consequently, relying on so many different methods can result in lack of communication interoperability (Barthel, 2012). Sharing Barthel's pessimistic view, Timmons (2007) blamed the inefficiencies on relying completely on technology without the proper proportions of training and practice, which relate to the research problem calling for effective training that would prepare first responders for good communications interoperability.

Barthel (2012) claimed that whether the disaster is natural or derived from human attacks, all responding organizations must "respond, manage forces, and provide critical support as a cohesive team" (p. 1). Such organizations include tribal, local, state, or federal levels and their fire, medical, and law enforcement responders. United, they give efficient, integrated, and timely responses effectively through communication, control, and command (Barthel, 2012). Further, key to that integrated response is communication interoperability (Barthel, 2012). Finally, the main goal of the NSS is to reinforce security and as a result, safety. However, if all else fails, rapid response and recovery must result through intense collaboration of government and private actors, and to ensure such collaboration, the United States must invest (budget and policy) in communication

interoperability for those who respond first to increasing homeland disasters (Barthel, 2012).

During a wildfire, there are many obstacles to the intelligibility of radio signals. Background noise of different kinds can be a factor (Atkinson & Catellier, 2012). Atkinson and Catellier (2012) used a test in which the communicator said a word and then another word that rhymed with the first or last consonant. It was played back using a vocoder under different conditions (no background noise, with a fire truck pump panel, an SCBA mask, low and higher alarms, a rotary saw, a chainsaw, a fog nozzle, an amplified mask, and combinations of the conditions such as with a mask and a rotary saw cutting a metal garage door). Overall, though there were some environments where neither was intelligible, analog radios performed better than digital ones (Atkinson & Catellier, 2012).

Numerous reasons can be pointed to for inadequate or failed radio interoperability. It is understood that communications barriers often materialize from insufficient radio infrastructure, but they can also result from the behavioral reactions of first responders in stressful situations, dysfunctional intergovernmental relations tied to inadequate policies and inadequate training (Huyck, 2015). Lack of broad-based training and confusing procedures can lead directly to the failure of radio networks. These factors show up as a multilevel lack of interest when it comes to instituting innovative operational policies, which often differ markedly from routine habits and deep-seated practices (Huyck, 2015). To modify and convert the radio systems would require updated

policies, and unfortunately, these polices are almost always ineffective due to their obsolescence in today's demanding conditions (Huyck, 2015).

It is clearly up to regional policymakers to work together to plan ways to obviate failed communications barriers wherever they occur. In an early work, Brito (2007) argued that lack of interoperability between law enforcement officers and firefighters, in the same city, could lead to devastating consequences. That rationale extends to emergencies that involve outside jurisdictions that must have cooperation among various agencies. Furthermore, the most simple emergencies necessitate cooperation between fire and law enforcement teams (Brito, 2007). While urban centers like New York have good interagency collaboration, smaller cities have not yet reached their interoperability goal (Brito, 2007; Wang & Zlatanova, 2016).

The failure to have reliable radio interoperability has, all-too-often, given rise to critical situations, which result in the further-on failures to carry out the mission or its operational necessities and which, in turn, have resulted in injury and, in some cases, loss of life (Hutchins & Timmons, 2007). To an observer, unacquainted with the on-the-ground exigencies of an emergency situation, radio equipment might be first looked at as being the primary reason underlying the lack of radio interoperability (Hutchins & Timmons, 2007). However, in support of the claim of experts that improving or upgrading hardware is neither a totally-viable nor comprehensive answer to the problem, Hutchins and Timmons (2007) have elaborated on another avenue for overcoming a significant part of the problem, that of training and the funding thereof, which is in support of two of the principal themes of this dissertation. Although they observed

funding for training that came with grants for better interoperability, which demonstrated recognition of the importance of the issue, their application to training was not specified well. As a result, when jurisdictions did note training in their grant applications, they did not iterate the specifics of the actual training.

Such lack of accountability is an important statement of concern with respect to the issues at the heart of all three elements of this dissertation. It speaks to the need to allocate funds more effectively—not to waste resources on expensive hardware (the budgeting factor), without understanding what type of equipment would actually be operationally beneficial. Hutchins and Timmons (2007) further pointed out the need to organize the proper training programs on how and under what circumstances the equipment is to be utilized–altogether referencing budgeting, training, and policy factors. They offered a series of observations with regard to various aspects of training programs and how to address the various interoperability inadequacies noted:

- Training on prioritization of radio messages and introduction of the concept of communication alternatives, other than public safety radio.
- Face-to-face communication and sector-level task coordination are [examples] of ways to achieve objectives without the use of radio resources.
- Unacknowledged messages to the incident commander are an area of concern….
- Have personnel at the emergency scene assigned exclusively to facilitate communications support for the incident commander.

Usually, there is limited transmission in normal radio-frequency coverage in buildings (Hayes, 2015). An intra-volume centralized array might work for building public safety systems (Young et al., 2013). Young et al. (2013) reported on how wireless devices were arbitrarily placed in different building locations to ensure higher radio interoperability. They found that this array strategy could boost transmissions up to 10 dB, using only four elements. Additionally, though, with only two elements, simulations and measurements averaged 2 to 6 dB.

Ewart and Dekker (2013) explored how talkback radio can create a sense of community during disasters. Members of the audience contribute to the narrative during crises as they play out. The researchers argued that such programs can pose challenges to normal communication and government actors because the community uses talkback programs as a means of obtaining direct information in a politically homogeneous group. The audience members can also subvert authoritarian control of the message. Ewart and Dekker concluded that this kind of control from the bottom to the top is similar to using a social medium. Still, it is not exactly the same because there is still a degree of editing and control to public access in talkback radio.

Issues Regarding Communication Technologies

Technologies have been used to develop state-of-the-art communications but in times of disaster, such as in the days before and after Hurricane Katrina made landfall in New Orleans in 2005, they can obstruct easy communication (Davis & Robbin, 2015). Davis and Robbin (2015) examined response networks whose job it was to focus on evacuating people, giving them shelter, and protecting the public. They researched

federal policies and local disaster planners, organizational networking, and communication technologies (ICTs), using grounded theory to show how failures in sharing information, communicating, employing technology reduced the efficiency of the organizational network and thereby led to significant loss of lives. Davis and Robbin concluded that those responsible should use a different theoretical framework to test the probability of disasters as well as social-ecological system discernment and committing and investing in data, metrics, and indicators to check progress toward resilience. Finally, they recommend adopting a more global perspective and investing in strengthening and redesigning infrastructure (Davis & Robbin, 2015).

Organizational and Technological Responses

There are no uniform public safety communication standards in the United States but rather it is a patchwork phenomenon with a variety of frequencies, protocols, and systems (Huyck, 2015; Mountjoy, 2005). The response to this unhappy state of affairs by the State of Texas was, in collaboration with the DHS, the preparation of a statewide plan for improving interoperability in crisis situations. The *F Plan* employed a network approach using demonstrable leadership at the regional level through the Texas Councils of Governments (COGs) and adherence to the DHS's national technical requirements for wireless public safety communications and interoperability (National Public Safety Telecommunications Council, 2016). One of the key elements of this plan is the SAFECOM Interoperability Continuum illustrated in Figure 2. This diagram depicts the core facets of interoperability according to a state's need for organizational preparedness.

Progression along the Interoperability Continuum is contingent on the following key drivers: (a) leadership commitment; (b) fostering collaboration across disciplines (EMS, fire, law enforcement, and all public safety agencies) through leadership support; (c) using interoperability solutions regularly; (d) coordinating across all elements (frequency of use, governance, standard operating procedures, technology, and training/exercises); and € progressing along all the elements of the continuum in parallel (DHS, 2011). Significantly, Figure 2 shows that nationwide efforts have now begun to demonstrate that there is an expanded characterization of interoperability beyond just the technical (the components of the radio equipment's hardware and software). Such efforts include addressing the external deficiencies having to do with behavioral and procedural elements as well (DHS, 2008). Behavioral deficiencies speak to the need for more practicable operational training; deficient procedural elements speak to the need for innovative policy adjustments, in addition to the operational training with respect to observing and carrying out the newly-formulated policies.

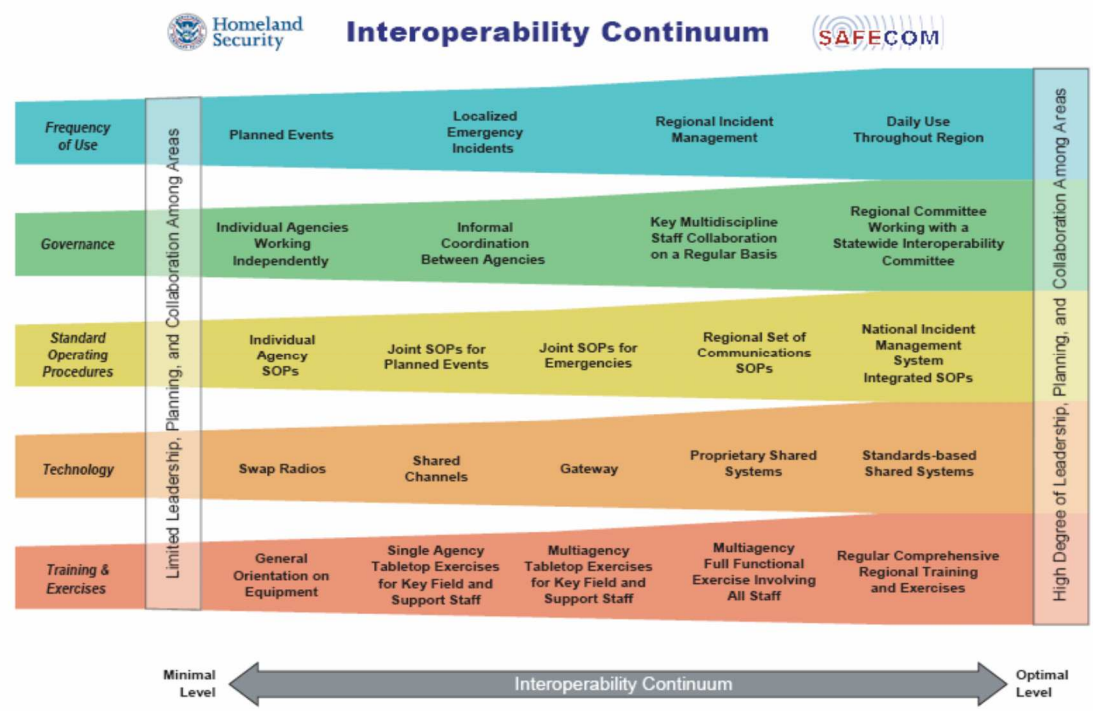

Figure 2. Interoperability continuum. *Note*. Retrieved from http://npstc.org

Kożuch, Małyjurek, and Kożuch (2015) discussed both vertical and horizontal communication in emergency management as important factors of responsiveness involving independent agencies. While vertical communication involves the creation of guidelines and norms for operations, horizontal communication involves flexibility in the organization and building relationships to align with unstable circumstances and other variables (Kożuch et al. 2015). Firefighters, law enforcers, and medical emergency crews are closely linked due to their status as first responders. Other units to which they are linked are private agencies, service agencies, and social organizations, to name a few. These interorganizational relationships rely on formal and informal ties and organizational and legal regulations. Therefore, the networks that have to function in

disasters and other crises should develop relationships every day to develop mutual aid, trust, commitment, and consciousness (Kożuch et al., 2015). Finally, the greater and more dangerous the disaster, the more important the need to use advanced systems of communications due to the abundance of real-time information that has to be processed to make the best decisions (Kożuch et al., 2015).

Similar to Kawasaki et al. (2013) in their study involving crowdsourced geospacial volunteers, Kryvasheyeu and Chen (2014) limited their study to users of varying geo-locations of the Twitter social network. The researchers analyzed Twitter messages in the pre, actual, and post super storm event known as Hurricane Sandy. The framework of the study was the *friendship paradox*'s behavioral and topological properties. Kryvasheyeu and Chen found that an advantage was gained in the centrality of users' networks and whether the participants were outside of the hurricane's radius or within it determined the extent of the advantage users had. Whether inside or outside the disaster area, they found a universality in emotional response, which can open "a possibility to implement a simple *sentiment sensing* technique that can detect and locate disasters" (Kryvasheyeu & Chen, 2014, p. 1).

Technology (radio communications equipment) is at the heart of radio operability, but, as with any mechanically-devised systems, technological challenges do arise. It was on an emergency training exercise on Long Island in New York that one of the unforeseen, but serious, technological challenges in regards to interoperability was identified (Martinez, 2014). Martinez (2014) cited a case in which problems involving beyond-line-of-sight arose due to interference with operating 800 MHz portable radios

from reinforced below-grade structures. The problem was solved by placing relay personnel along the sight line of the communications. Although the strategy was not the preferred nor long-term solution to the problem, which had to be addressed at a later time, it does reveal a significant ancillary aspect to the role of training with regard to radio interoperability.

In summarizing the state of interoperability across states, Henry (2012) reported that in general, planning activities stemming from grants lacked integration. Even emergency alerts and other important notifications fail to cross state boundaries and when they are operable, other area responders often cannot interpret them correctly (Henry, 2012). As a result, not only are efforts duplicated, but they also show gaps in the ability of emergency personnel to be prepared and able to go through with needed response to crises.

Henry (2012) posited that there is an ongoing issue involving the ability of personnel from states to connect technological analysis with intelligence and coordinate sectors linking homeland security with public health. With varying culture, business strategies, and missions, it is difficult to link the practices of both sectors (Henry, 2012). Much of homeland security is classified and thus cannot be shared with public health institutions regarding decision-making and planning. Regarding budget, grants for federal preparedness are decreasing; otherwise, fusion centers and public health preparedness could function. Consequently, to save funds, state leaders are attempting to consolidate programming, to collaborate, and to eschew duplication in the midst of rising crises and natural disasters (Henry, 2012). In addition, in relating technology to budget issues, much

of the equipment is obsolete with high replacement costs. Furthermore, Henry emphasized that technology is key to interoperability to the extent that, without equipment, there can be no communications (Henry, 2009).

Wireless technology seems to be a solution toward communications interoperability, but it is not without threats to secure communications. Although wireless networks for communication serve public safety networks well using endpoints such as cell phones, tablets, laptop computers, and mobile camcorders, the same system can pose security risks due to complex interconnectivity issues (McGee, Coutière, & Palamara, 2012; Oxendine, Sonwalkar, & Waters, 2012). The complexity involves combining coworkers, video surveillance, endpoints, sensor systems, and communications in general. If the networks are breached by criminals, then others could gain access as well.

McGee et al. (2012) warned that public safety and first responders may not be familiar with the newer innovative networks though they do know how about controlling physical security, redundancy, and encryption. Lack of knowledge may compromise the systems; thus, crime databases especially need protection. McGee et al. discussed the challenges in public safety network design. Security threats pose the need for protection against eavesdropping; protection against corrupted information; securing internal network interfaces between network elements; protection against data exfiltration; protection against denial of service; and securing the operations, administration, and maintenance network (McGee et al., 2012). Maintaining the security of a network is challenging in the face of disaster. Therefore, it is imperative to incorporate strong security measures in the beginning with scheduled follow-up involving assessments and

audits so that the endpoints in addition to the network are “securely available under extreme conditions” (McGee et al., 2012).

Shouldis (2013), in discussing radio communication in fire departments, noted the importance of communication for command and control. In using a fire protocol known as CARDS, firefighters can recognize every communication and transmit assignments completed throughout the combined statistical area (CSA). This structure consists of nonprofits, public entities, and private companies. CARDS is an acronym that relates the following: C-Completed assignments must be sent to the IC so awareness of the situation can be ascertained; A-Acknowledge every message to improve good decision-making; R-resource requirements that change depending on the situation so that all human resources, apparatuses, or equipment is readied in a staging area; D-Dangerous situations that can be found by on-the-ground firefighters so they can radio the changing conditions to obtain appropriate responses (e.g., conditions that might alter offensive responses to defensive ones; and S-Silence to turn responders into listeners rather than reactors when appropriate). A web-based portal overlaid on an Internet cloud can help the information exchange be smooth and effective (Shouldis, 2013). However, it is necessary to safeguard safety, performance, and security when using cloud technology (Liotine, Howe, & Ibrahim, 2013).

Communication Pre- and Postdisaster

In a postdisaster study, Bilve et al. (2014) assessed the need for an early warning alert and response network or EWARN to mitigate risks of transmissing diseases of epidemic proportions. As a result, emergency personnel would be better prepared for

detection, assessment, and response to diseases that follow a tsunami. A tsunami did hit the Solomon and Santa Cruz Islands in early February 2013 and killed 10 people. Over 4700 others lost their homes. In the Santa Cruz area, two-fifths of the population was displaced, and those who were had to live in temporary camps with primitive conditions. There was little access to clean water or sanitary facilities. Only a few weeks after the disaster, the EWARN system was operational so that negative health conditions could be reported right away. Within a two-month period, people could be informed about 1177 syndrome or target disease cases, which led to an 85% compliance rate of reporting data and no epidemics during the time of displacement (Bilve et al., 2014). Such a system can function both as early prewarning and postdisaster emergency management that can save lives at all stages of a disaster.

Community Involvement

Not only is interoperability the responsibility of first responders, but also of members of the community who are involved in a disaster (Hardie & Kitchen, 2014). Hardie and Kitchen (2014) recommended that communities investigate how to run efficiently a multidisciplinary, multiagency exercise. The researchers conducted a case study with the purpose of providing a framework for planning and learning how the components interact with the primary objective of not giving up on individuals needs in the face of achieving common goals (Hardie & Kitchen, 2014).

Areas prone to cyclones have been the scenes of millions of deaths for the past 200 years. However, the mortality in Bangladesh has decreased from half a million deaths 40 years ago to just over four thousand in 2007, largely through coordinated community

efforts (Haque et al., 2012). The significant reduction is mostly due to improved shelters, evacuations, early warnings, reforestations, and built up embankments in coastal areas along with better communication and raised awareness. Rather than build large centers, it is more practical to use existing places (set every two kilometers) were people congregate such as schools and mosques (Haque et al., 2012).

Educational programs for children in primary schools on cyclones, for an example of community involvement, can be based on a model used in Cuba, and houses in vulnerable areas should be raised more than 3 feet off the ground. Most important, policy makers, planners, and developers should rely heavily on local knowledge for adaptation and environmental planning (Haque et al., 2012). One of the most important themes of improving communication interoperability, as has been noted by many researchers, is to coordinate local, state, and national efforts and insure transparency over secretive government control so that all first responders and the people they protect can coordinate their efforts to prevent slowdowns in interoperability that can result in loss of lives (e.g., Atkinson, 2014; Bertrand, 2012; Fu, Zhou, Zhang, Chan, & Burkhart, 2012).

Political Interference with Communication in Other Countries

Natural disasters are widespread on the increase all over a rapidly changing environment, and leaders of many different nations have all had to address the role of communications interoperability during these challenging swaths of destruction (Fabac, Đalog, & Zebić, 2015). Often, through media or official government reporting of these disasters, discrepancies exist between reality and what the public is allowed to know. In western Russia in 2010, a series of wildfires destroyed almost 10 million hectares of peat

areas and forest land (Bertrand, 2012) emphasized the consequences when data come from government sources. To Bertrand (2012), the reporting discrepancy is significant. Although the Global Fire Monitoring Center reported the 10 million hectares, the Russian government reported only 1.8 million hectares of damage, which was lower than that of the previous year. This underreporting served to communicate the competence of the government in its ability to address and overcome disasters. However, it also highlighted how strictly information is influenced and controlled by government policies.

Although the main role of government as competent leadership was confined to the recovery phases, most of the quelling of the disaster in the response and emergency management stages was in the hands of first responders and other forces. However, to bolster the image of the government, Vladimir Putin conveyed that the fires (160,000 total in 2010) were "personal, delegated, and impossible" (Bertrand, 2012, p. 39). Bertrand argued that this power personification was one of a leader's omniscience that could be viewed as a legacy from Soviet times. The government personification portrayed a state of technology with complete control of disasters, which in reality does not guarantee security (Bertrand, 2012).

In a similar case regarding government policy in the face of natural disasters was the Sichuan earthquake in China in 2008. The event led to the deaths of almost 69,000 people with almost 18,000 people missing and 46 million people either injured or affected negatively (Fu et al., 2012). In an analysis of media coverage, the hardline policies of the Chinese government were exposed in the aftermath of the disaster. Mass

media are important in their ability to communicate public information how people can obtain safety and security during a crisis.

During the earthquake, foreign and Chinese media were allowed to issue detailed reports on the event, which was a departure from the usual controlled media by the central government where images of the devastation were projected globally even though government leaders made efforts to restrict the media content (Fu et al., 2012). Reporters ignored the warnings and continued to report, opening a 2-week window into the disaster. In their comparative report, Fu et al. (2012) contrasted the strategies of government media vs. market-oriented media. In spite of more open media policies in the United States, Fu et al. found that in the U.S. disaster used for comparison, Hurricane Katrina, the U.S. media capitalized on supports from institutions and responses of government (a thematic framework) instead of individual anecdotes and responsibilities (an episodic framework).

Not only do emergency responders and the public need to know all of the consequences of a natural disaster, but scientists also must have all the facts to be able to make assessments from an objective view. Shore (2013) emphasized communications as a necessity for scientists who are learning difficult lessons from Fukushima. Scientists need to communicate with each other as well as the public better. Shore's panel under the Radiation Effects Research Foundation (RERF), where radiation investigations have been carried out for 60 years, compiled an account regarding risk estimates for radiation in an environment of high uncertainty. Their data were used by WHO for its report, which was received by many groups both nationally and internationally. Limitations included the

overplaying or underplaying of a serious situation by the press and by government officials, which makes policy setting challenging. The panel members determined to abide by science alone without giving in to political pressure. Still, everyone was brought to the table and allowed opinions (Shore, 2013).

The biggest controversy involved the level of radiation to which people had been exposed (Shore, 2013). Thyroid cancer was the biggest risk, and again, because of government policies and secrecy, children were drinking milk from exposed cows days before the public was informed about the extent of the danger of this devastating natural and manmade disaster. On the other hand, the press, looking for sensationalism, overplayed parts of the Fukushima aftermath. Therefore, they planned to neither exaggerate the information nor cover it up (Shore, 2013). Eventually, the Japanese government and accepted the legitimacy of RERF's findings, which are ongoing. The committee had also been gathering data on the survivors of the atomic bomb, yet even with these people ranging from their 50s through 60s, they do not yet know the degree of genetic risk there is genetically (Shore, 2013).

The media culture of being a watchdog, which is prevalent in other places is only at the beginning stages in China (Fu et al., 2012). Contrasting thematic and episodic frameworks showed different focuses. Market-oriented media shows more transparency in communicating disasters at all stages. Fu et al. (2012) acknowledged that the provincial media can be significant in their ability to give full coverage to unfolding stories because they are somewhat less regulated than are government media. Nonetheless, the impact would be less significant if no government policies allow the

deregulating of media and more open information sharing, policies that become more significant on a global scale as government bias interferes with transparent communication though media censorship and political influence (Fu et al., 2012). Thus, the need for such transparency is paramount for policy makers.

Alternative Strategies to Ensure Communication Interoperability

Often, especially in remote areas where wildfires rage, there is lack of conventional radio interoperability as well as access to cellphone and Broadband towers. Alternative strategies are necessary to save lives. They include balloons, smart earth satellites, and mobile stations. The widespread mobile networks can be used by most people to receive alerts and colorful hot air balloons can convey warnings in remote areas (Haque et al., 2012). In connection with this balloon technology (Haque et al., 2012), in the United States, the Federal Communications Commission wrote regulations for aerial stations including balloons that could ensure radio interoperability in the case of areas experiencing large-scale disasters that have cause their communication system to go down (Magnuson, 2012). Some of these systems can transmit for up to four full days after a disaster has taken place. Space Data of Arizona has used balloons that fly at high altitudes for military and industrial applications. These altitudes, known as *near space*, do not have high winds and they also have a wide range for radio interoperability (Magnuson, 2012).

Another system that can aid in interoperability in remote areas is smart earth observation satellites (Visser & Dawood, 2004). These satellites can not only take high-resolution photogrphs, but they can also yield significant amounts of data with little to no

upgrades on the current system: "Remote sensing satellites currely operate on a 'store and forward' paradigm, where data [are] stored on the satellite until the satellite is in view of the ground station" (Visser & Dawood, 2004, p. 893). Subsequently, the data can be telemetered below where emergency responders can be assured of necessary information. The purpose of Visser and Dawood's research was to elaborate the design of this synchronous system on a mission to monitor and detect the events during natural disasters. Further research involved assessments of fire fronts and tracking of fire movement (Visser & Dawood, 2004).

Agencies at the local, state, and federal levels as well as private entities are all working together to try to ensure communications interoperability. However, among loss of service, bureaucratic snaps, and competing private agencies, alternatives have their challenges. In response to large-scale crises like the September 11 attacks and Hurricane Katrina, a National Emergency Communications Plan was developed by the DHS (Hu, Knox, & Kapucu, 2014). However, when later disasters like Hurricane Sandy hit, as much as a quarter of all cell phones and other communication media lost service (Insinna, 2013; Piotrowski, 2013). Although emergency managers have been seeking radio interoperability in different localities, they learned much about the vulnerability of the system in a disaster (Insinna, 2013). Most importantly, when general communications are down for days, there is no way to call 911 to get immediate help. Satellite companies have offered what their executives think is the perfect solution, but rather than location diversity, there is only vendor diversity when two companies can be in the same area and are therefore vulnerable when satellite service can go out (Insinna, 2013).

Furthermore, in emergencies, vendors may not be readily available on off-business hours and satellite communication can also be cost prohibitive. The Red Cross had moving satellite services in vans, but they work with 50 different partners, some private (Insinna, 2013). Unless there is much advance preparation, some weak links in the communication chain can cause the entire system to collapse. At one point, the Red Cross had to fall back on making announcements on bullhorns and handing out printed flyers in communities because all technology had failed (Insinna, 2013).

Congress in 2012 allocated a portion of the communications spectrum known as the D Block with a cost of $7 billion to implement. Instead of developing a stand-alone network, they decided to use existing infrastructure for wireless communications (Insinna, 2013). There are many budget shortfalls to address over the years it will take to build the system but it is a legislative priority. However, additional problems arise when small localities cannot afford the equipment necessary to run the system. It is challenging to get all first responders to use standardized devices that would lead to better communications interoperability (Insinna, 2013). Still, some work is being done in different locations. In Bethpage, Long Island, the DHS Center is working with first responders via tabletop exercises so private innovators can see first hand what emergency managers do so that all entities can be prepared for the next natural crisis (Insinna, 2013).

During a crisis, emergency response has always involved volunteers. In the digital age, volunteers can be virtual too. One form of communication is through conventional geographic information systems, or GIS, which has been updated to a format that can attract wide participation and thus becomes "more dynamic, more transparent, and [more]

decentralised" (Kawasaki et al., 2013, p. 201). As acknowledged by Fu et al. (2012), the earthquake in Sichuan lacked a coordinated response due to conflicts between governmental and market news data. To arrive at a solution for coordination of information, the Center for Geographical Analysis at Harvard University developed a geospacial portal to connect to a global community; they found that the timing of the project was vital (Kawasaki et al., 2013). Through browsing geospacial data and web mapping, a wide network, not imaginable 10 years ago, can use both professionals and volunteers from the public to mitigate disasters. Such crowdsourcing is the wave of the future that will only grow in the next several years (Kawasaki et al., 2013).

The Role of Social and Other Media

Propagating information in emergency situations is key to emergency managers, no matter the operational scale. Such issues have become most apparent over the past 15 years. Communication gaps among governmental agencies and citizens have often led to scores of deaths and injuries (Wukich & Mergel, 2015). One way to reduce these gaps is through social media, though media are never a first resort in emergencies (Wukich & Mergel, 2015). Lacking in the research are all phases of emergency management; most research is based on response and recovery phases, Wukich and Mergel (2015) analyzed a 3-month period of Twitter messages to analyze all emergency management stages. They found that some agencies used interactive approaches to disseminating information, many-to-many and one-to-one even though the majority of messages were more traditional government communication protocols that involved the government communicating with thousands of citizens (Wukich & Mergel, 2015).

Reinforcing the idea that social media cannot be overlooked as an important communication interoperability tool, is the example of the terrorist attack in Kenya in 2013 at the Westgate mall, which resulted in 147 people injured and 67 deaths (Simon, Goldberg, Aharonson-Daniel, Leykin, & Adini, 2014). During this 4-day seige, Twitter became more than social media but a "crucial channel of communication between the government, emergency responders and the public, facililtating the emergency management of the event (Simon et al., 2014, p. 10). TwitterMate is a data gathering tool for "tweets," and this system collected, stored, and scrutinized outstanding hashtags that came from the accounts of emergency responders, NGOs, and private citizens. The 67,849 tweets were divided into four categories: terror attack, geographical location, organizations, and social support (Simon et al., 2014). That way, the threat assessment could constrantly be updated. Social media are widely accessible and should be seriously considered during disasters in which large numbers of people are involved. Furthermore, procedures should be standardized so emergency managers can monitor, synchonize, and integrate feeds to give out public information and crucial responder material (Simon et al., 2014).

Taking a variety media into consideration serves well at all stages of a disaster, whether over cell phones, television, news portals, SMS, or microblogs; such media can play a part in pre-warning to ensure community safety and security (Zhang et al., 2014). Furthermore, because individuals of different ages, genders, and socioecnomic have varying preferences for the type of media they use, dissemination of disaster prewarnings will more likely result in almost universal outreach (Zhang et al., 2014).

Policy

The U.S. government has been especially involved in creating policies to update and fund emergency management systems and consider recommendations of experts. Emergency communications, whether in a terrorist attack or a natural disaster like a hurricane, are vulnerable. The GAO (2011) recommended that the DHS put in strong efforts to implement the National Emergency Communication Plan. The key areas of vulnerability are in "capacity, communication, and interoperability continuation response in communities" (p. 481).

To develop the broadband network sustainably, funding sources needed identification. From a policy perspective, Moore (2011) made several recommendations including the need for sufficient funding, development of radios that would match the spectrum, a governance structure to oversee effectiveness and uniformity, and collaboration with commercial entities to have enough resources in knowledge and skills. Budka et al. (2011) echoed Moore's (2011) emphasis on the importance of the broadband network, adding that the U.S. Federal Communications Commission had chosen the Long Term Evolution or LTE application to develop the U.S. Public Safety 700 MHz band. Budka et al. posited that both the LTE-based broadband for public safety and the required movement of narrowband system to thinner channel widths would facilitate carrying critically important services over the LTE. Budka et al. presented some of the challenges intrinsic in working with legacy narrowband systems, emphasizing interoperability.

Having an emergency alert system is essential for all kinds of emergencies, either a new one or through an existing one. To employ the latter, all personnel in the system

whether on the state or local level should complete the Integrated Public Alert and Warning System process, known as IPAWS so that both law enforcement and other emergency responders can communicate security and safety issues (Leiva, 2014). The Integrated Public Alert and Warning System or IPAWS was set up by FEMA in 2004 to integrate the federal Emergency Alert System as well as other systems to save lives and lower damage to property (Goldstein, 2013).

The Government Accountability System (GAO) in 2009 revealed that there was slow progress in effecting IPAWS. Thus, both the FCC and FEMA did a national EAS test in 2011 so that GAO could review it including (a) what barriers are affecting implementation of IPAWS and (b) to attend to the weaknesses identified. GAO recommended closer work between the FCC and FEMA so that states will have the necessary guidance to test EAS regularly and to assess IPAWS components. The DHS agreed with the recommendations of the GAO, giving examples of what actions could be taken to comply with the recommendations (GAO, 2009).

Baldini, Fovino, Braghin, and Trombella (2013) discussed a new "wireless communication technology that allows for adaptive configuration of the reception parameters of a terminal, based on the information collected from the environment" (p. 925). The spectrum sharing can work in the military, for commercial use, and toward public safety. Baldini et al. stated that in some cases, policies must be enforced to allocate resources via spectral bands. These policies should reveal which users can access them, what resources are available, and what circumstances must exist. Thus, it is important to establish protocols in advance should an authority come on the scene and confusion result

from unclear directives. Baldini et al. presented a framework involving trust negotiation to ensure distributed access policies that rely on more than one party.

In 1988, based on the Association of Public-Safety Communications Officials, a project was inaugurated known as Project 25 (P25) or APCO-25. The project encompassed standards for digital public-safety radio and radio communication in general for North American countries (Tuite, 2012). P25 went beyond two-way communication between dispatchers and first responders but as dispatchers in the role of a connection to other agencies, usually via telephone. During the time that P25 was in operation, mostly for hardware, officials were working on standardizing methods for multiple agencies to work together when small events turned into disasters (Tuite, 2012). Tuite (2012) gave an example of the Colorado wildfires where fire safety and law enforcement agencies worked together on many levels from local to federal in addition to ground and air forces from the Bureau of Land Management and National Forest Service. Around 2011, the Harris Corporation launched BeOn, an innovation that allows its subscribers communicate, whether they are on public-safety or cellular networks. Although not previously true, Harris updated their technology to have P25 capacities (Tuite, 2012).

Involved in the difficulties in organizing caterers, ground crew members, helicopter pilots, borate bombers, and Red Cross workers, to name a few of those involved in fighting a natural disaster, the Incident Command System (ICS) had many challenges. To apply training and planning for such events, the entire system must evolve; standards cannot be rigid in the face of communication innovations (Tuite, 2012).

While some agencies use on frequency, others use multiple frequencies. Moreover, there are times when people must go off network and instead use portable repeaters or repeaters on vehicles or communications radio-to-radio. Tuite describes ICS as one that emphasizes planning and structure and that the command structures required should be simple (Figure 3).

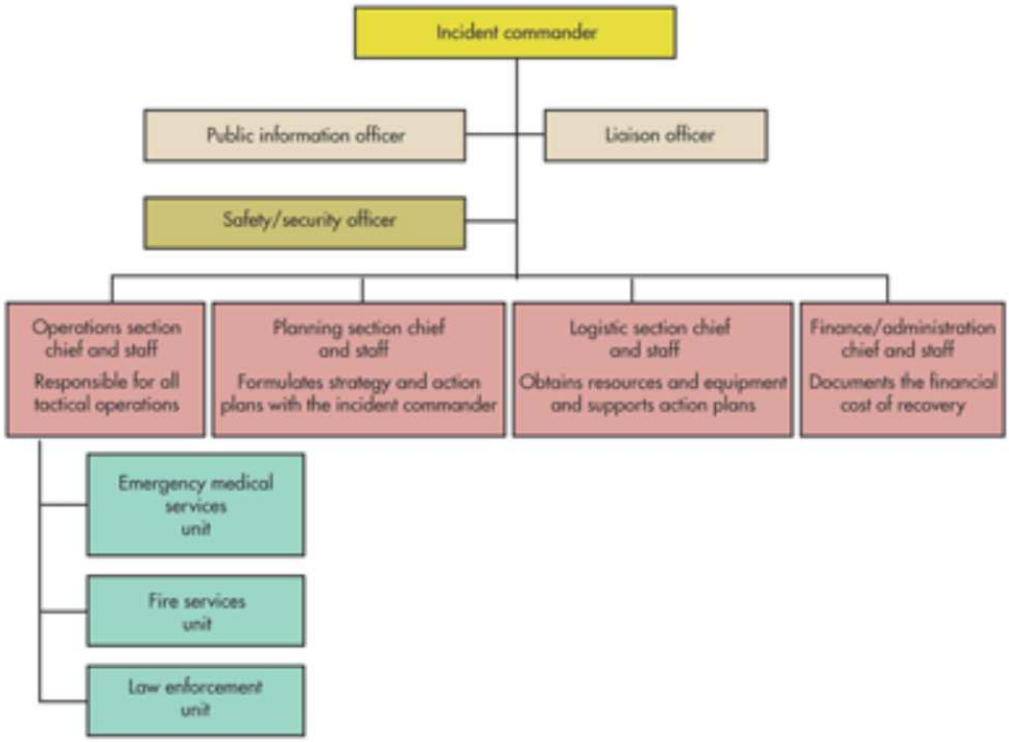

Figure 3. The ICS structure

To be effective to the fullest extent during a crisis and in its aftermath, emergency responders must consider wireless communications in capacity and capability as well as giving accessing public space and roaming capabilities to public safety networks (Moore, 2011; Moore, 2013). Thus, there needs to be public policy behind such wireless

expansion. An expanding spectrum for radio frequencies is essential for public safety. Moore (2011) argued that the network to suit this spectrum needs building and the equipment capable of meeting the new mobile Broadband standards must be developed and deployed. Moore outlined three bills before Congress that obliged the FCC to "transfer a spectrum license intended for commercial use, known as D Block, to the license holder for adjacent frequencies already assigned to public safety, known as the Public Safety Broadband License" (p. 149). A few years later, the U.S. Congress was to consider a First Responder Network Authority or FirstNet and the Next-Generation Communications for Public Safety by the Congressional Research Service based on the Middle Class Tax Relief and Job Creation Act of 2012. Seven billion dollars were provided for costs in planning and launching FirstNet (Moore, 2015).

Budget

Huyck (2015) argued that it is only when public policies from the local to the national levels find funding for emergency managers to ensure radio interoperability in the long run. If networks are to be expanded technologically, then not only training and planning are necessary but also ways to have adequate budgets to meet the unfunded mandates (Huyck, 2015). Furthermore, it is not funding alone that will promise solutions but also consensus in the cultures and missions among first responders on how to reach full interoperability in emergency communication (Huyck, 2015).

Many fire departments, for example, do not have access to the most up to date equipment and larger departments that do, do not always use the equipment on a regular basis or have integrated it into standard procedure (Huyck, 2013). Additionally, grants

are available to fund some of the mandates, but agencies may not hear of their availability on time or miss deadlines (Huyck, 2013).

One example of federal funding was signed by President Obama, where the United States government initially funded the P25 network for $7 billion. This network involves 10 "MHz of paired spectrum in the 700-MHz band for public safety, allowing a 5-MHz channel in each direction" in addition to a 700-MHz network for broadband services for the public-safety community" in a tax relief bill (Tuite, 2012, p. 5). The network will continue in its innovations for 3 to 5 years. In a Harris Corporation demonstration, access at a distance to the high capacity system at the core was shown and dispatchers could see police cars and know it was ready for communication through push-to-talk calls via the BeOn application. The application has P25 features through broadband.

Training/Response

According to Henry (2009), "Interoperability requires the commitment of different agencies in the public safety community with responsibilities in a time of crisis…. To that end, 31 states used a Statewide Interoperable Governing Body (SIGB) to administer interoperability programs in state government" (p. 9). This is an important advancement in the matter of support for radio interoperability touching explicitly on governmental policies. Nevertheless, Henry also contended that implementation remains a challenge in five key areas which introduces the issue of training as well:

- Informal oversight and governance;
- Uncoordinated Standard Operating Procedures;
- Incompatible and obsolete technology;
- Infrequent and inconsistent trainings and exercises; and
- Difficulty integrating interoperability into routine, daily use.

To be successful, interoperability requires shared management, control, policies and procedures and must be multidisciplinary and multijurisdictional (Henry, 2009). The solution seems simple: The deficiencies are well-defined and clearly enumerated, and the state-wide plan has been established through its SIGB, so, why not move ahead with overcoming the evident deficiencies? The fact is that there are several major external barriers standing in the way of correcting such deficiencies. Simply stated, irrespective of the existence of an agreed-upon plan in any given state, there can be key jurisdictions, which do not have the legal or jurisdictional authority or the financial wherewithal to proceed with the stated implementations, to say nothing of a particular locale's recalcitrance to yield its unique status in this regard to some state-wide authority (Henry, 2009). Added to that, in the situation in which a certain locale is unwilling to adapt itself to such authority, the governance authority may not have the legal right to compel it to do so (Henry, 2009).

In spite of conventional training, first responders must also improvise their behaviors in disaster responses. In a study on improvised behavior, Mendonça, Webb, Butts, and Brooks (2014) claimed that responses to disaster are known to be conventional or improvised. However, Mendonça et al. statistically analyzed reports done by law

enforcement officers who responded to the Murrah Building bombing in Oklahoma City and the World Trade Center in the 911 attacks to explore their thinking processes behind their emergency responses. Careful coding by multiple researchers of the reports revealed that crises of large proportion can help researchers understand social structure. The narratives were classified and identified as behavior if the actions were related to disaster roles and cognitive if related to goal orientation, hypothesis, or observation. The study complemented and continued research that links disasters and the cognitive processes of first responders after training so that responses to such crises can be more deeply understood (Mendonça et al., 2014).

Ristoska and Gjurov (2014) emphasized the importance of communication training from a well-educated and prepared emergency responder staff. To obtain the support of a regional or national population, responding institutions must not only communicate through the media but with the public. In the Republic of Macedonia, leaders initiated practical training through simulations and other exercises. These trainings are held in a regional training center established by the Department of Defense and since 2013 is known as the NATO Training Center for Public Relations. The goal is to develop different communication and public relations skills to meet various political crises and natural disasters (Ristoska & Gjurov, 2014; Stănescu, Boeriu, & Copotoiu, 2016).

Much can be learned from large scale emergencies, and first responders are willing to share what they did to aid in overcoming future disasters**.** Zane et al. (2012) reported on the most massive wildfire in Texas history and the largest destruction of

residences since 2007 on a national level. Their purpose was to share the experience so that future first responders could learn how to respond with minimum loss of property and lives. Ultimately, the disaster led to two deaths of civilians and 1,660 destroyed homes and took give weeks to contain. In the first part of the response period the Texas Department of State Health Services prioritized the most important problems that needed addressing, among them communication and emergency public information in addition to commanding and controlling the disaster, looking to the safety and health of first responders, providing them shelter, attempting to monitor behaviors regarding the disaster, surveillance and epidemiology, and disseminating and managing medical materials.

Regarding communication, the Department issued press releases statewide in two languages toward public health issues related to the wildfire including smoke precautions, how to evacuate and what to bring, and assessments of public health in the community. Locally, messages to communicate risk were updated via the media and people were directed to a conference center for messages that covered specific topics including the need to update tetanus shots and how to prevent injuries from the intense heat. Medical personnel staffed 24-hour hotlines. The wildfire started September 5, 2011 and was contained five weeks later in early October. Figure 4 shows the 5-week timeline of the disaster. Zane et al. (2012) concluded that first responders in most regions of the United States could benefit from learning about the strategies they used so that they could improve their own preparation and response to similar disasters.

Sunday, September 4 (wildfire started)

Monday, September 5

- **State Medical Operations Center (SMOC) virtual activation**
- **Deployed ambulance bus (ambus)**

Tuesday, September 6 (33,089 acres burned, ~ 500 homes destroyed, 0% contained)

- **Activated the SMOC**
- **Issued statewide news releases on "Wildfire Evacuations: Here's What to Bring" and "Wildfire Smoke Precautions"**
- **Initiated epidemiology and surveillance activities**
- **Monitored the status of nursing homes located in affected area to ensure any evacuations were adequately supported**
- **Local Disaster Behavioral Health response activities began**

Wednesday, September 7 (~789 homes destroyed, 0% contained)

- **Deployed the Mobile Medical Team**

Thursday, September 8 (~1,386 homes destroyed, 30% contained)

- **Started delivering medical resources to local shelters**

Friday, September 9 (2 civilian deaths discovered)

- **Issued statewide news release on "Use Caution During Wildfire Recovery'**
- **Activated pharmacy contracts**

Sunday, September 11: (50% contained)

- **Demobilized ambus and assigned crew**

Tuesday, September 13 (~1554 homes destroyed, 70% contained)

- **Deactivated the SMOC**
- **Wednesday, September 14**
- **Demobilized the Mobile Medical Team**

Friday, September 23

- **Issued statewide news release on upcoming community health assessment in Bastrop County**

Saturday and Sunday, September 24 and 25 (95% contained)

- **Conducted public community health assessment**

Tuesday, October 9 (~1660 homes destroyed, 100% contained)

Figure 4. Texas wildfire response activities by date

On the state level, research has been conducted to develop a framework for improving awareness of emergency situations (Hunter, Yang, Petrie, & Aragón, 2012). Because disasters and emergencies can be so large in scale, public health professionals have seen a need for emergency preparedness exercises. Hunter et al. (2012) developed their study based on an epidemiological framework to conduct a survey to evaluate the capabilities of the emergency system in response to a crisis scenario and the challenges among organizations in managing information and organizing communications. The respondents came from 121 hospitals 24 EMS agencies, 35 health departments (local), and 5 regional disaster medical and health specialists and coordinators in the state of California (Hunter et al., 2012). Particularly significant were the number of responses in regard to communications systems and equipment that indicated partial or complete failure of the systems, which is the main problem in the present study (Hunter et al., 2012). The researchers concluded that their results offered a beginning point for dialogues among emergency responders about their responsibilities, roles, and challenges regarding communications among various agencies and how to intervene to optimize communications interoperability.

Qualitative Research on Emergency Communication

Various qualitative peer-reviewed studies have been conducted in the emergency management field (Anthony et al., 2014; Broomé, 2013; Klappa et al., 2014; Yang et al., 2010), though few have been conducted about lack of communication interoperability during a disaster. Anthony et al. (2014) investigated the system for hurricane warnings in a southwest state regarding the experiences of boundary spanners such as emergency

managers, weather personnel, and National Weather Service forecasters in in-depth interviews of almost 2 hours of 10 such people. Anthony et al. found that they were going after what seemed like conflicting goals. Consequently, the communication was "strained" (p. 468). These strains entailed the timing of the dissemination of information in contrast to access and accuracy of information as well as information attribution.

Revere et al. (2015) explored communication technologies that are employed bi-directionality between stakeholders and public health agencies as well as the use of texting from mobile phones to ensure that marginalized populations (geographically) could receive alerts. In a mixed methods approach through both surveys and interviews targeted to health agency workers, providers, and government personnel, the researchers asked respondents and participants how texting or a bidirectional system could perfect communications in emergencies with contrasts between local and national crises or pandemic and health updates. Revere et al. found email was favored for public health messages but for larger events the decision on what modality to use is complicated but must be managed well so everyone benefits.

Broomé (2013) interviewed law enforcement officers regarding their psychological responses to pursuits, events that may be necessary in the case of terrorist attacks. Broomé found compared to an earlier study where attitudes ranged from overconfidence to impatience, that the officers had anxiety about performance once they realized their responsibility in the chase and focus on outcomes and consequences. These aspects can be like choking in sport performance; thus, to be competent first responders,

Broomé recommended that law enforcement consult with sports management organizations to enhance their psychological skills.

Yang et al. (2010) interviewed nurses in China who were first responders (a role for which they were not fully trained) to an earthquake that took place in 2008. The purpose of the study was to explore their response to this disaster. They found the experience they went through overwhelming because they felt they were not trained to know exactly what to do. Yang et al. found that the three most significant reactions of the nurses was (a) strategies for coping and challenges, (b) relearning their role as caregivers and helpers, and (c) feelings of unpreparedness. The researchers highlighted using education and training specifically for disasters; otherwise, nurses would not be collaborative, efficient, productive, and stress-free.

Summary

In this study, I take the position that there is a long-term solution to lack of interoperability in emergency communication: Training, budget and policy, properly conceived, put into effect and exercised in a combined and balanced effort are what is needed to fill in the missing elements leading to full radio interoperability in emergency situations and crises. The literature presented in Chapter 2 was based on the communication aspect of emergency management, in addition to how it is affected by public policy, training, and budget. Researchers have agreed that natural and human crises are rising at an alarming rate due to climate change and political instability (Barthel, 2011; Davis & Robbin, 2015; Sun et al., 2013; Stack, 2015). In a thorough review of the literature, lack of communications interoperability is prominent in all

studies whether due to incompatibility in training and equipment or from political interference (e.g., Fu et al., 2012; Henry, 2012; Huyck, 2015; Kożuch et al., 2015; McGee, 2012; Liotine et al., 2013; Mountjoy, 2005). As the result of lack of communication interoperability, many lives have been compromised or lost.

Lack of radio interoperability is the most important issue, for that is the first line of communication for first responders battling a wildfire or monitoring civil unrest. However, when such lack of radio interoperability is the issue, policy makers, trainers, and communities put in their best efforts to overcome the crises with everything from balloons (Haque et al., 2012); satellite technology (Insinna, 2013); community preparedness (Hardie & Kitchen, 2014); to legislating better networks that ideally would ensure standardization of communications in emergency management such as P25 and IPAWS (Goldstein, 2013; Tuite, 2012). Currently, individuals have stronger networks than ever before in the history of humankind due primarily to social networking. Social networking has indeed helped save lives and institutions do use them as much as possible such as the widespread Amber Alerts on cellphones (Burtness & Ober, 2013; Wukich & Mergel, 2015). However, social networking and use of Broadband systems is not ideal for emergency managers due to the lack of security. Systems can be and have been hacked (McGee et al., 2012).

The importance of radio interoperability in emergency situations and crises is crucial and well accepted as being essential to ensuring the well-being of first responders—even to the saving of their lives—as well as the well-being of those victims whose life and limb may be at risk. Various meanings have been attributed to the term

radio interoperability, but in the final analysis—in *reality*-- radio interoperability does not exist today, not in its unequivocal form of guaranteeing 100% reliable radio communications at every emergency site. This, unquestionably, is a serious problem, as witnessed in the summer of 2015 in the Wenachee WA fires in which 3 firefighters were trapped and killed (NASA, 2015; Zane et al., 2012).

Numerous solutions to the problem have been proposed. The federal government, for example, in recognition of the problem, has responded by establishing a line-up of federal agencies, all with the same underlying purpose of tackling the problem, but those efforts have been found to be limited in their effectiveness (Goldstein, 2013; Leiva, 2014). More recently, however, the idea has emerged that training, effective budgets, and updated policies may hold the key to a viable solution. These approaches are directly in line with the thesis of this dissertation which posits that regular, well-planned training and training exercises, well-conceived and well-coordinated expenditures on compatible forms of equipment and sound training and sound, broad-based and well-devised federal, state and local policies hold the ultimate answer to achieving reliable radio interoperability in all types of emergency situations and crises.

Conclusions

This study posited that the elements of training, budget and policy, properly constituted and followed through with, are key elements in establishing radio interoperability in emergency situations and crises, and that there is an abundance of articles in support of that position. In researching the literature, abundant support with regard to the validation of those issues is also found. I have advanced the position that

training, budget and policies, properly formulated and supported and adequately promulgated will satisfy most, if not all, of the requisites for achieving the stated goal. The research in support of these premises are derived from information and data collected from first-hand interviews with experienced first responders to emergency situations who work in either a large city, a small towns, or a rural community in California, Texas, and New York. Chapter 3 presents the qualitative methodology with which I conducted the study as well as the research goals and procedures used to collect and analyze the data.

Chapter 3: Research Method

In the preceding chapter, I posited that training, budget, and policy have an integral relationship with communications interoperability and, by extension, unfettered emergency-site communications. In Chapter 3, the method is presented for gathering and analyzing data from interviews conducted with experienced first responders from the states of California, Texas, and New York. The aim of this study was to gain an overview of the current difficulties experienced by firefighters and law enforcement personnel in those states in quelling emergency situations and how their efforts have been impeded, or completely thwarted, by the lack of communication interoperability. This chapter sets out the methods to be used in this undertaking: the goals of the research and the detailed procedures to be followed in the collection of information and data. Additionally, informed consent and ethical considerations for the participants are elaborated on within this chapter.

Research Design and Rationale

The research questions in the study were as follows:

1. How do first responders describe their experiences in emergency situations that involve lack of communication interoperability?
2. What is the role of budget and training in connection with communication interoperability and the policies that might be instituted to improve the safety of emergency responders?

I reviewed different methods for my study. The main research methodologies are quantitative, qualitative, and mixed methods. Quantitative research is mostly statistical,

and researchers use instruments that are largely predetermined or developed and tested with the goal of seeking correlations among variables or testing hypotheses (Wahyuni, 2012; Yin, 2014). This kind of research is objective and can eliminate bias; mixed methods are a combination of qualitative and quantitative research (e.g., conducting a survey and recruiting some of the respondents for in-depth interviews). I did not plan to find correlations or cultivate hypotheses, but instead explored first responders' experience with the lack of communications interoperability as well as the role of budget, training, and policy in emergency preparedness.

Qualitative research involves the collection of rich experiential data through interviews, document review and observations – narrative rather than numerical data (McCusker & Gunaydin, 2015; Yin, 2014). These kinds of data can reveal the social motivation of individuals as well as their lived experiences in natural settings. In qualitative studies, the researcher is obligated to maintain an ethical attitude toward the participants and confidentiality (Damianakis & Woodford, 2012). A variety of qualitative traditions are ethnography, grounded theory, case study, and narrative inquiry along with phenomenology (Yin, 2014).

Case study can consist of not only interviews, but also observations and document review and is used to explore the perspectives of the participants regarding events, activities, and bounded programs (Yin, 2014). Because the study involved the actual experiences of what resulted in breakdown of communications interoperability, rather than on general points-of-view on disasters, case study did not fit the study. Grounded theory is a way by which researchers can analyze unexplained phenomena, name

integrated concepts, and build theories from qualitative data (Foley & Timonen, 2015). Because I was using three out of many communication theories that already exist to guide the study, there was no need to construct a new theory on lack of communications interoperability.

Narrative inquiry is also used to develop theories regarding "psychological and social process" (Lal et al., 2012, p. 6), and as stated, no need existed to construct new theories for the study. Lastly, ethnography involves studying groups of people over time in their natural settings, and how they participate in that setting (Petty et al., 2012). The basic qualitative interviews for the study were relatively short in duration, and the participants were not being observed in their workplace or an actual event in which they were in the role of first responders, but rather how these first responders recalled experiences they have already had. The kind of qualitative research that best fit the study was a detailed exploration of the participants' experiences regarding communications interoperability during crises; thus, a basic qualitative study was the best choice.

Role of the Researcher

Snodgrass (2014) noted that the qualitative researcher can interpret the data to understand how the participants can make sense of a phenomenon they have experienced. As a current first responder with over 25 years' experience in emergency mitigation, I was confident I would be able to extract the broad-based data from the cases studied and make detailed analyses to derive cogent appraisals of the data. Furthermore, my personal experiences as a first responder aided in substantiating the credibility of my results.

My background and personal experience with emergency situations have enabled me to understand the vernacular of the participants and the descriptive verbiage typically utilized in after-action reports. Based on my personal experiences as a first responder, it has become clear to me that the elements of training, budget, and policy can either support or corrupt an emergency situation, with the latter having a knock-on effect of negatively impacting communications interoperability. The participants for the study, however, were not personally known to me or supervised by me. Nevertheless, my long-time perspectives as a first responder might have led to bias towards their situation, for I have been in many emergency situations as a former first responder. Still, in my role as the researcher, I followed ethical guidelines, including member checking as well as any needed follow-ups on the interviews to prevent subjectivity in this area in which I have had extensive experience (Denzin & Lincoln, 2011; Hofmeyer et al., 2012; Yin, 2014).

Methodology

The qualitative method of research was selected as the most appropriate approach in this study, for it involves exploring and understanding the personal experiences of first responders who have faced life-threatening situations when lack of communications interoperability was a significant factor in their effectiveness. A basic qualitative design in particular is the best tradition for the present study because it is used to understand what an experience means in the context of those who lived it, the essence of an individual lived experience (Petty et al., 2012). In qualitative research, the researcher focuses on persons currently involved in the kinds of situations being studied and records

their experiences in a common frame of reference. The goal of this research is to develop rich, in-depth data from the participants.

Participant Selection Logic

The sample of 18 interviewees was drawn from a national representative population of emergency first responders. Interviewees for this study were drawn from six fire and law-enforcement departments in three different states: California, Texas, and New York. These three states were selected for two reasons: the first is that these states are the most populated ones in the nation. The second involves the states' disparate geographic locations, urban and rural. The variable aspects of the cities and towns selected were designed to determine (a) how population size or location affects the ways in which communications interoperability may vary from location to location, and (b) how each locale has organized its training procedures, budget considerations, and policies to provide and support communications interoperability in emergency situations. The prospective participants were either currently working or recently retired in the role of a first responder. Moreover, the participants selected had to have a minimum of 10 years of service in responding to emergency situations. This criterion was deemed as being necessary for the participant to have a sufficient amount of work-related experience with communications interoperability.

The data collected from the sample population were used to develop themes about the lived experiences of the emergency responders. It would have been difficult and costly to collect data from an entire population of law enforcement personnel and firefighters in the United States; therefore, the rationale discussed previously for the three

states and participants involved in the study can be justified. Frankfort-Nachmias (2008) stated, “Methodologically speaking, a population is the aggregate of all cases that conform to some designated set of specifications” (p. 79). The sample population provided a wide variety of experiences for both firefighters and law enforcement officers in rural, urban, and small town jurisdictions.

The sample population should be a realistic and accurate representation of the population for the study to be reliable (Yin, 2014), and in this instance it certainly kept the research more reasonable and affordable. Once I received permission to recruit participants and receive responses, I sent out information involving anonymity and confidentiality and details about how the participant would receive a survey via his or he personal email. This survey was completed by the participant and then returned via email to me. If a survey was returned incomplete, or if I deemed follow-up information was needed, I arranged for individual phone interviews for additional clarification that would span anywhere between 15 and 30 minutes.

If the initial contact letter did not generate the numbers I sought to continue with this study, I made additional attempts to recruit participants for the study by contacting additional first responders. However, I did not anticipate having issues getting a sufficient number of participants, for many first responders have expressed frustration about the lack of communication interoperability in crisis events and wanted to share their experiences (Kehl et al., 2014; Verkuil & Fountain, 2014). Still, if that was not the case, and fewer people volunteered, I planned to implement snowball sampling, where those

who committed to be interviewed were asked to recommend others in firefighting or law enforcement for additional interviews (Atkinson & Flint, 2001).

Instrumentation

As a researcher in a qualitative study, I was the primary instrument in gathering data (Yin, 2014), which were the results of in-depth semistructured surveys of 18 participants from the states of California, New York, and Texas. The participants were comprised of one firefighter and one law enforcement official from an agency that serves a large population, one of each from a small agency such as a volunteer firefighting agency or law enforcement agency of fewer than 25 sworn personnel, and one of each from a rural agency with a large land base and small population. During the interviews, I took handwritten notes and used bracketing to avoid bias.

Chan, Fung, and Chien (2013) noted that gaining in-depth understanding of the participants' experiences is the most important goal. Still, researchers are human, which surely influences research. Thus, researchers should bracket their own experience with the aim of minimizing their influence, including assessing mentally one's own personality and keeping a reflexive diary (Chan et al., 2013). After a professional transcriber transformed the recordings into Word files, I allowed the participants to review the transcripts to make their accuracy certain prior to analyzing the data for emerging themes regarding budget, training, and policy as they related to lack of communication interoperability for first responders during a disaster or emergency.

Procedures for Recruitment, Participation, and Data Collection

A general overview of the study was e-mailed to the administrators of each fire and law enforcement agencies. The e-mail solicited their approval to collect data from their staff, and to speak with the various staff members meeting the criteria stated in previous sections of this chapter with the goal of selecting one participant from each agency to interview. The e-mail was then followed up with a survey sent, again, via e-mail to each participant. If needed, I planned to phone interview participants who could provide additional responses to their initial reply. In the phone call, if needed, the participant would be provided language with a stated understanding that the goal of the study is to explore how budget, training, and policy impact communication interoperability for first responders in an emergency situation.

Once the potential participants were identified, I sent an e-mail to each of them via their personal e-mail addresses, introducing myself and explaining the nature of the study. I also delineated their options at any time to withdraw from the study and their participation, or lack thereof, to the study would have no bearing on any workplace evaluations, promotions, or demotions, and that their responses would remain anonymous to their colleagues and supervisors. Once the interviewees agreed to the interview, a copy of the informed consent form was submitted via e-mail to the respective participants. When the informed consent form was returned to me via e-mail, I followed up with the participant in an e-mail for the participant to complete the survey. Again, if needed, the one-to-one phone interview questions were intended to be open-ended for the first responders to elaborate on their experiences in various emergency situations. The focus

of this methodology was to report the experiences of the lack of interoperability and how these experiences of can be aligned to budget, training, and policy within the aforementioned fire and law enforcement agencies within the cities being studied.

Surveys sent via a personal e-mail offered a low-cost way of gaining access to respondents' input that might otherwise be difficult to secure in person, due to the widespread distances involved. One clear disadvantage of an e-mailed survey, however, is the reduced amount of nonverbal interaction with the respondents. Because I was not able to observe the facial expressions, body language, and other physical cues of the respondents, I had to rely on my own experience as a first responder to discern the level of frankness and veracity, which is basic to a qualitative study, for such an approach allows and encourages direct interaction with the subject. In the process, I was confident that my more than 25 years of experience as a first responder would enable me to engender a sense of comradeship with the respondents, encouraging them to open up to the questions posed and to be forthright in the answers delivered (Opdenakker, 2006). Prior to beginning the e-mailed survey, I restated, in writing on the opening page of the e-mail, the aim and conditions of the study and asked if the participants still wished to continue with the study.

The survey was conducted in a semistructured fashion (Yin, 2014). Each participant was asked a number of open-ended questions. The questions were the same for all the participants at the outset, but, because the sessions were intended to be free-flowing, different responses emerged, which could have extended the time of the interview to a greater or lesser extent. Additionally, the semistructured format allowed

participants to freely discuss how their lived experiences on training, budget, and policy affected radio interoperability, or the lack thereof. The survey took each participant no more than 45 minutes to complete and, if deemed appropriate for my study, a follow up phone call was made to various participants whose initial replies needed more clarification. This follow-up phone interview lasted no more than 30 minutes. Listed next is the initial survey that was mailed to each participant:

1. Please share a lived experience in which radio intercommunications were compromised.
2. Can you explain the internal operations of how communications are relayed during an emergency?
3. To what extent do you believe a nationwide communication system would lessen errors in an emergency response?
4. In your experience, do you believe you have adequate training on the use of radio operability? If not, what can be improved?
5. In your experience, do you believe your respective agency (i.e., police or fire department) has adequate radio communications equipment for their first responders?
6. Have you ever experienced a situation as a first responder in which radio equipment simply did not work?
    a. Would you describe the nature of that situation regarding the equipment: was it operator error or something else?

7. Thinking about your current work setting, do you believe there is adequate communication regarding the policy surrounding radio interoperability?
    a. Do you think this policy can be improved?
    b. Why or why not?
    c. How so? (if, yes)
8. How long have you worked in the state of ____ (either California, Texas, New York) as a first responder?
    a. If you have worked in another state in this same capacity, were there similar issues regarding radio interoperability?
    b. Can you share an example of those similarities?
    c. Was your previous location larger or smaller in employee size compared to where you are now or your most recent experience as a first responder?
9. What is it like when you're in an emergency situation responding to a scene and you experienced either a failed or faulty situation regarding radio interoperability?
10. Can you share with me how was the foregoing situation was resolved?
11. In your experience as a first responder, what stands out most regarding lack of communication interoperability?
12. Is there anything you would like to add that you feel we have not covered?

To remain in alignment with the research questions and subtopics of budget, training, policy, and equipment as related to radio interoperability, each of the above questions related to the overall study. Specifically, Questions 1, 5, 7b, 8a, 8c, and 9 related to the area of budgeting within a given agency. Questions 4 and 6 related to equipment.

Questions 2, 3, 6a, 7, 7a, 7b, 7c, 8a, 8c, 9, and 10 had the themes of policy. Questions 4, 7b, 8a, 8c, and 9 related to training. Several questions that were asked were indicative of more than one theme and were aligned and mentioned as such. Finally, Questions 11 and 12 were the most open-ended; therefore, they could be interpreted in all four themes of budget, equipment, policy, and training.

For those participants I contacted for a follow-up phone interview, I notified each interviewee when the audio portion of the interview was being recorded and when the audio recording ended. I also took handwritten notes to augment the recordings to be used to prevent bias and to aid in data analysis (Yin, 2014). The handwritten notes augmented the recording of the interview and further instituted privacy and general interview compliance best-practices. The note taking process was also in accordance with the qualitative method of case study design for it allowed me to obtain rich data as experienced by the participants in the study (Yin, 2014). Participants were informed that they could exit the interview at any time with no questions asked and no obligation to provide any further information. At the end of the interview, the participants were encouraged to add any information they felt had been left out of the interview questions.

The interview session ended with a statement of appreciation for the participant's time and a reminder of the two-step follow-up process and options for not participating, if the participant decided otherwise at that juncture. During the next three days following each returned survey and phone interview, I organized my interview notes. The digital recordings could be sent via email to a professional transcriptionist who signed a confidentiality agreement to transcribe the interviews with transcription software.

The first follow-up step was an opportunity for me to review the transcribed interviews for accuracy. I sent the transcriptions to the interviewees via personal email for them to check for accuracy and completeness. The second follow-up step was the option to receive a copy of the completed dissertation. After two more days, I followed up with a phone call to determine if the transcription accurately reflected the interviewee's responses and if any revisions were needed.

By implementing end-use strategizing, I was able to visualize how this study could be applied to firefighters and police officers in the respective states who participated in this study. Moreover, end-use strategizing also allowed me to conceptualize immediate implications of this study—that are further addressed in the forthcoming chapters—and how the comments from the participants can be generalized to other disciplines within emergency management. For the purposes of replication and duplication of my study by other researchers, my steps were as follows:

1. A general search was conducted to determine the three most populated states in the nation.
2. After those states (California, Texas, and New York) were identified, I then searched for three locations within each state of being a large-sized city, a mid-sized town, and a rural community all within each respective state for a total of nine locations within the United States.
3. Once these locations were determined, I researched these areas to confirm each large sized city, mid-sized town, and rural community contained both a fire

company and a police station. Both of these entities might not always exist, especially in rural communities.

4. Upon verification of these states and communities having the needed disciplines, I was able to contact Mr. Dixon Robin, National Response Team Leader (supervisor) Emergency Response, who was able to provide me with a list of 73 firefighters and police officers who had at least 10 years of service as an emergency responder in either the discipline of being a firefighter or a law enforcement officer.
5. Because Agent Robin has coordinated teams of emergency responders across the United States, he had access and working knowledge of emergency responders from various disciplines. This list was sent to me via my personal email.
6. All 73 people on the list provided by Team leader Robins were contacted via email by the researcher and were given the appropriate Institutional Review Board (IRB) documents for review and consent.
7. As consent letters were returned, I then sent each participant the survey via their personal email.
8. When participants emailed me stating they were unable to complete the survey due to time constraints, but still wanted to participant in the survey, I asked them, via email, if we could arrange a time convenient for them so that I may call them and obtain their responses during either a face-to-face or telephone interview.
9. Once I received 23 consents, I terminated collecting and soliciting any further responses, for I was only seeking 18 participants. An additional five consents

were collected in case one or two of the original 18 participants decided to withdraw from the study.

10. For those participants who went sent the survey via their personal email, they were given one week to complete the questions and return it to my personal email.
11. For those participants I either met face-to-face or spoke to over the telephone to obtain their responses, I recorded, with their permission, the responses to each question.
12. In these calls or the face-to-face meetings, I asked the participant to have in front of him or her a copy of the survey and before we began the interviews, based on the surveys from the survey, I reminded the participants of the IRB consent and their right to terminate the conversation at any time during the interview.
13. I, then, began to record the interview and started with question number one.
14. I took notes to what the participant stated during the interview and, again, the entire interview was recorded.
15. This process continued for each of the remaining questions on the survey.
16. When all questions were answered, I thanked the participant for his/her time and transcribed the entire interview from the recording device.
17. Upon transcribing the interview, and along with the returned written responses from the participants, I searched for themes and ideas that were derived from the data.
18. The major themes that emerged from the data were inconsistencies relating to budget, policy, training, and interoperability.

Data Analysis Plan

Due to the small number of 18 participants interviewed for this study, I decided upon hand coding as the best method to analyze the data. As the primary and sole researcher for this study, hand coding allowed me to consider themes the participants discussed, to hear intonations in the participant's telling of incidents, and to understand how the expression of these themes created a situation of danger, confusion, and pure lack of interoperability for emergency responders. Hand coding allowed me, as the primary researcher, to determine which words, phrases, themes, were communicated the most. Furthermore, hand coding allowed me to organically develop the ideas generated by the participants and natural, logical themes manifested from the hand coding method.

The survey data were coded using the participant's words and themes first, followed by thematic code names represented in the literature corresponding to this basic qualitative study (Yin, 2014). When all the surveys and interviews were transcribed and reviewed, I looked for categories and themes that emerged through the responses of the participants obtained with manual coding of key phrases that stood out. Such a strategy helped with organizing content, coding, and identifying themes to gain more in-depth exploration of the experiences of first responders who have had issues regarding lack of communication interoperability. To further demonstrate alignment between the research framework and research methodology, I extracted particular themes, statements or data as given by the participants from within the study and compare it with all other themes, comments, and data that may have been similar or different to develop conceptualizations of the possible relations between various pieces of data.

Soon, a pre-set list of four codes became apparent: *budget*, *training*, *policy*, and *interoperability*. As the researcher, I also created a code book in which one definition was created based upon the compilation of these words from the participants during the interviews. I, as the researcher, could then begin to formulate questions such as: How is the lack of radio interoperability experienced differently for those first responders who work in California as opposed to those first responders who work in Texas and New York? As with most qualitative studies, this study was intended to generate knowledge about common patterns and themes within human experience. The specificity regarding this study, though, focused on the lack of communication interoperability as seen through the lens of training, budget, and policy. I was attempting to determine to what extent budget, training, and policy create interoperability, or a lack thereof, for an emergency responder within the three most populated states in the United States. The emergency responders were limited to the disciplines of firefighting and law enforcement within either a big city, a small -sized town, or a rural setting with a minimum of 10 years within the respective discipline.

Issues of Trustworthiness

Credibility

First, member checking can also enhance credibility and I shared the transcribed interview to make certain the all of the participants confirmed the accuracy of their words and individual perceptions. If any of the participants' objected to the accuracy, they could help to provide better wording. Second, if participants did not offer detailed answers, using follow up probes helped to verify what they meant to say such as "May I have an

example of a training protocol?" or "I need a bit more clarification on the strategy you used."

Transferability

Transferability, or external validity, can be established by eliciting thick descriptions of lack of communication interoperability during disasters and seeking variation in participant selection. For these reasons, participants were drawn from three states spread far across the country from two different kinds of first responders (law enforcers and firefighters) in three types of settings (an agency that serves a large population, a small agency of fewer than 25 sworn personnel, and a rural agency with a large land base and small population).

Dependability and Confirmability

I planned to employ a reflexive analytical strategy to enhance dependability and confirmability, which acted as my personal assessment of what I perceived during the interviews. Note taking by hand in a journal helped track the daily activities and methods used as well as bracketing to minimize bias (Lincoln & Guba, 1985). In the journal, I noted carefully any ideas, thoughts, or personal attitudes during the semistructured interviews.

Ethical Procedures

The participants were asked to sign informed consent forms in pursuance to their agreement to participate. To maintain the integrity of the data, a password-protected external hard drive was used to transfer all data initially collected from my desk-top

computer. The external hard drive was password protected that only I, as the primary researcher, would have access to throughout the duration of the study.

An informed consent form initially was distributed via email to each participant in the study. If participants agreed to participate in the study, the form was returned and an electronic signature was accepted. I enforced the specified wait period as described in the earlier section of this chapter regarding data collection. These procedures were in full alignment of the researcher obtaining consent for each participant in the study. The participant had to review, sign, and verbally acknowledge her/his understanding of the depth and breadth of the questions before any portion of the interview commenced and data were collected (Creswell, 2009).

Participants were informed in writing, through their informed consent forms, and again, verbally, prior to the beginning of the phone interviews, that their identities, linking any of them to any particular responses, were not to be communicated to any organization, publication or person, nor would any incentives or penalties that might affect their positions be attributed to their answers. In addition, every effort was made to ensure that the participants understood the intent of the study and their role in collecting the data and that their responses were only be used in the context of this dissertation. They were further informed that they could terminate the interview at any time or retract any or all of their responses.

Furthermore, all materials, including informed consent forms, phone interview notes, phone interview transcriptions, and any and all electronic communications are to be retained by me under lock and key for 5 years following the final acceptance of this

dissertation by the university. At that time, all materials are to be properly and thoroughly disposed of.

Finally, I did not conduct the study in my own work environment with coworkers or anyone else known to me; therefore, there was no conflict of interest or difference in levels of power, in which case the interviewers might not be entirely forthcoming with their experiences as first responders during disasters.

Summary

This chapter outlined the methodology of my study. Specifically, I discussed why a qualitative approach was the best method of choice for my research and provided a clear justification for this method. Additionally, I detailed why this study followed a basic qualitative procedure and how my data collection procedures aligned it to such a tradition. This chapter should support and provide confidence of the level of rigor and reliability needed for the topic of lack of interoperability and how the concept of the lack of it was also dependent on training, budget, and policy. Additionally, in this chapter, I provided a discussion on who would participate in the study, the rationale for the selected participants, and why this topic was necessary for research exploration.

Chapter 4: Results

The purpose of this study was to explore and understand from the perspectives of first responders how they ensure their own safety and that of others during an emergency situation. The basic qualitative study was based on their reliance on radio communications interoperability whether over a network or directly between emergency responders. Dependable communications are intrinsically connected to budget, policy, and training in the context of the present study. The research questions that guided the study are the following:

1. How do first responders describe their experiences in emergency situations that involve lack of communication interoperability?
2. What is the role of budget and training in connection with communication interoperability and the policies that might be instituted to improve the safety of emergency responders?

Chapter 4 is organized into the following sections: (a) research setting that sheds light on anything that can influence the findings; (b) demographics to explain the participants' professional backgrounds as well as the settings in which they work (e.g., rural law enforcement agency in Texas, urban firefighting department in New York); (c) how the data were collected; (d) how the data were analyzed; (e) evidence of trustworthiness including credibility, transferability, dependability, and confirmability; (f) detailed presentation of the findings; and (g) a summary of how the research questions were addressed by the findings and a statement of the content of Chapter 5.

Research Setting

Data were collected from the 18 participants through in-depth semistructured telephone interviews in a quiet location of their choice, but not at their place of employment. Thirteen of the participants were interviewed telephonically; three face to face, and two via e-mail. The participants came from the states of California, New York, and Texas. Many of them were coping with budget cuts and lack of training and effective policies, yet such circumstances made them very motivated to engage in the research and share their information. Participants were comprised of one law enforcement official and one firefighter from a big city, a small town with fewer than 25 first responders and a rural agency with a small population yet with a large land base in each state.

During the interviews, none of the participants disclosed any current personal or organizational conditions that would have influenced their experience at the time of the study that could impact the research results. One female participant disclosed she worked a fire scene approximately a year ago, which was traumatic for her shortly after the incident, but based on observations, she did not indicate any emotional behavior such as crying, or sudden change of vocal intonation or vocal expression during the interview regarding the explanation of this event. Moreover, the participant remained neutral in tone and moved on to the next question without incident. I did take handwritten notes along with bracketing to minimize bias.

Demographics

The participants represented a diverse sample of first responders across the three most populous areas of the United States (see Table 1). The participants were further

broken down to determine the frequency with which each respondent stated something negative or of concern regarding their respective agency in terms of budget, training, policy, and interoperability. These terms are identified in Table 1 as B (budget), T (training), P (policy), and I (interoperability). These responses were generated from the survey questions and while some of the responses from the participants were directly mentioned as either being of concern in some capacity, others responded as having concerns in the themes of budget, training, policy, or overall interoperability.

Participants were of both genders, from different ethnic backgrounds, from either the firefighting or law enforcement agencies, and with varying years of service ranging from 10 to 30 years. Participants were numbered in the order in which their surveys were returned to my personal email or conducted to me. Because the participants were clear in their views about this issue, there was very little to insinuate from the data, for their responses were specific and direct about these concerns. Specifically, there were 18 respondents. Each participant responded to 12 main questions. All participants responded to all 12 questions so three was a total of 216 responses for the entire survey. Of the 216 responses, nine responses had a negative remark regarding budget. Specifically, these participants mentioned issues stemming from a lack of budget, budget cuts, or inequities between similar (same-sized) organizations and their own.

Table 1
Participant Demographics

Coded Name	Age	Race	Gender	Profession	State	Agency Jurisdiction	Years in Profession	Interview Method	B	T	P	I
P1	33	Caucasian	Female	Firefighter	NY	Small town	10	Face to Face	2	4	6	8
P2	41	African American	Male	Law enforcement	TX	Large city	16	Telephonically	0	1	1	0
P3	51	Asian	Male	Firefighter	TX	Large city	10	Telephonically	0	8	1	0
P4	40	Caucasian	Male	Law enforcement	CA	Rural	18	Telephonically	0	4	3	2
P5	45	African American	Male	Firefighter	NY	Large city	25	Telephonically	0	3	2	0
P6	39	Caucasian	Male	Law enforcement	NY	Rural	12	Telephonically	0	0	0	0
P7	36	Caucasian	Male	Firefighter	TX	Rural	15	Telephonically	0	9	0	0
P8	31	Caucasian	Male	Firefighter	TX	Small town	12	Email	4	0	1	0
P9	33	Caucasian	Male	Law enforcement	CA	Small town	13	Telephonically	1	5	2	0
P10	42	Latino	Female	Law enforcement	CA	Large city	20	Telephonically	0	0	6	0
P11	43	Caucasian	Male	Firefighter	NY	Rural	21	Telephonically	0	1	2	0
P12	33	Caucasian	Male	Firefighter	CA	Large city	12	Telephonically	1	2	1	0
P13	31	Caucasian	Male	Law enforcement	TX	Rural	10.5	Email	0	0	0	2
P14	32	Caucasian	Male	Firefighter	CA	Rural	10	Telephonically	0	0	1	0
P15	35	Caucasian	Female	Law enforcement	TX	Small town	13	Telephonically	0	0	1	0
P16	37	Caucasian	Male	Firefighter	CA	Small town	15	Telephonically	1	0	0	0
P17	52	African American	Male	Law enforcement	NY	Large city	30	Face to Face	0	1	1	0
P18	38	Caucasian	Male	Law enforcement	NY	Small town	14	Face to face	0	2	2	0
									9	40	30	12

Regarding training and concerns, the 18 participants mentioned training issues, either as being infrequent, nonexistent, or inadequate to their needs of their job 40 times in the overall survey. Policy was a concern and mentioned as such 30 times within the 18 respondents. Issues regarding policy were based on not knowing what the policy was or if the policy was still effective; or still appropriate to the needs of their respective departments. Finally, of the 18 participants, the overall sense of the lack of interoperability; or simply not communicating the needs of the supervisors to the emergency responders or the emergency responder not being able to fully communicate their own needs in an emergency situation, was discussed 12 times in the survey.

Data Collection

Eighteen participants took part in the interviews. Nine of the participants were firefighters and nine were law enforcement officers. Three of the participants were female and 15 were male. Four had more than 20 years of service. Ethnically, 13 of 18 were Caucasian, three African American, one Latino, and one Asian. Three participants were interviewed face to face, 13 telephonically, and two via e-mail.

The data collection process took place over a 4-week period. The data were recorded not only on participant surveys. The face-to-face and telephonic interviews were recorded and transcribed before they were analyzed for themes. The two people who responded by email did so via an encrypted email to an off-site secure separate email account. I was able to get everything needed with their responses, so no additional follow-up was needed. Each participant was contacted once. The participants, all law enforcement and firefighters, had varying experiences yet all of their responses were

related to the research questions. Consequently, nothing was discrepant in the data from the participants who were from multiple races, genders, and varying locations from the previously indicated states.

I recorded both the telephonic and face-to-face interviews on a Sony recorder with transcription software on speakerphone. The interviews were conducted in a neutral location, mutually agreeable to both the interviewer and participant, but additionally, not influenced by work environment on either side. They took place outside of work hours and on a personal line. Due to the security of the emails, there were no issues with email open-ended survey questions and written interviews. Regarding the two written interviews, the participants' location prohibited face-to-face data collection. Although telephonic interviews would have been the chosen method, their work schedule prohibited such a format.

Data Analysis

Participants were coded in the order in which they responded. There were 18 participants, thus, the codes were established as P1, P2, through P18. The data were hand-coded on an Excel sheet. The data can be divided into two categories and two subcategories determined by the research questions. The single, unifying word iterated or analyzed in the participant data was *interoperability*. Interoperability, or the lack thereof, impacts to what extent an emergency responder can communicate with other first responders (Huyck, 2013). When interoperability is compromised, it becomes challenging for the emergency responder to complete the task at hand. The second main theme encompassing was the theme of *budget*. The third main theme encompassing

theme on the graph was *policy*. The final main theme of this graph was *training* (see Table 2 for a visual presentation of the themes and subthemes in the study).

Table 2
Themes and Subthemes

Budget	**Training**	**Policy**	**Interoperability**
Equipment Update Delays Due to Emergency Budget Priorities	Need for Plain Talk Instead of 10-Code and Signals	Dependency on Own Dispatch in Lieu of Interoperability With Other Agencies	Lack of Communication Interoperability Costs Lives
Lack of Money in Small Towns and Rural Areas	Classroom Training Needs Rather Than On-the-Job Training	Lack of Coordination Among Agencies	Poor Radio Transmission Due to Variations in Equipment
Desire for National Communication System	Lack of Training Can Result in Liability Issues	Need for Coordination of Training with New Equipment and Policies	Having to Resort to Personal and Others' Cellphones
	Lack of Training Can Result in Injuries and Loss of Life		Difficulty Communicating in Large Buildings
	Need for Coordination of Training with New Equipment and Policies		Large Land Mass in Rural Areas with Sporadic Coverage
			Vehicle Radio Equipment Inadequate in Emergencies

I used a basic diagram depicting interoperability as the crux of the study, for without interoperability, emergency responders would be unable—and have been unable—to do their job according to the data analyzed from the participants. When there is a lack of interoperability, other crucial factors identified through the literature and in my framework as being budget, training, and policy, as well as themes discussed in the participant replies, suggested these three themes as being dependent, yet fluid to interoperability (Huyct, 2013). Specifically, interoperability serves as the end-all, be-all to an emergency responder. All of those surveyed stated in some fashion that interoperability was the single-most important need to save lives: albeit someone else's or their own.

The next critical word, as identified by the participants and their use of terms, situations, and experiences is that of budget. Without budget, there are not enough financial resources to uphold the need of interoperability. A healthy budget allows for emergency responders to impact policy that drives the purchases and training for emergency responders. Ninety percent of the participants acknowledged, in some form, that budget was a critical element for their own role as an emergency responder and the role of their individual department.

Within the main theme of budget, there were multiple subthemes that were noted as discrepancies within the issue of budget. These discrepancies varied from large city to the rural town and also varied from state; there were three subthemes that emerged from the data. These subthemes were (a) not having an appropriate budget to update the necessary equipment used by first responders and (b) no allotted of funds for emergency

responders to attend training, specifically on the integration of plain talk instead of a 10-code and signal system. While emergency responders understood the inequities of a budget between a large city and a rural town, 42% of those responded they were unclear as to why a small town and a rural community would have considerable disparities in budget. Of these 45% who stated this comment, more than half worked at some point in their careers as an emergency responder in both a small town and a rural community.

The third most critical word as reported by the participant's survey in this study was policy. However, it needs to be noted that effective policy is the key. Policy, for the sake of policy will not allow for emergency responders to complete their job. Policy, like budget, is created for the betterment of the responders. But, the concern of the participants, specifically, 27% of them, was that policy needed to be communicated. So this becomes an issue of interoperability, as well. While all of the emergency responders stated their unit had a policy in place for radio communications such as when to use them, how to use them, and who is to use them, 45% of these respondents stated these policies were learned on-the-job, or through colleagues who were later reprimanded for improper communication use. Therefore, it can be concluded that the policy may be denoted as a task list item, for the actual discussion appears to be lacking within many of these individual organizations.

The fourth most critical word as reported by the participants in this study was training. While all of the participants stated they received initial training to complete their duties as emergency responders, nearly 50% of those participants stated they had not received any ongoing professional development on the equipment since their initial

training. This is a problematic situation, for technology changes, skills change, the needs of a given community change, yet the training received from half of these emergency responders was more than 10 years old. The added problem here is that policy may not dictate any affirmations of updating the training, or there might not be appropriate budgeting to make it happen. Either way, this situation fosters an environment to poor interoperability.

Within training, there were four subthemes that emerged from the participant replies either directly stated on their survey or discussed in their phone interview. Research Question 1 addressed the lack of communications interoperability. Several subthemes arose related to this research question and the issues involved. Study Results

The present study on lack of communications interoperability was guided by two research questions: (a) How do first responders describe their experiences in emergency situations that involve lack of communication interoperability? and (b) What is the role of budget and training in connection with communication interoperability and the policies that might be instituted to improve the safety of emergency responders? This section will be organized by research question.

Research Question 1

Research Question 1 addressed the overall issues involving lack of communications interoperability, especially via radio. The interview data from the 18 participants from three states, two different kinds of agencies, and three different types of location (large city, small town, and rural areas) addressed the lack of communications interoperability throughout all the categories that were emphasized in research question 2.

As the first responders went through their daily routines as well as major natural, criminal, and political emergencies, they encountered many obstacles stemming from budgetary, policy, and training issues that hampered their ability to execute their duties to serve and protect the public.

The radio equipment itself was probably the biggest challenge in lack of communication interoperability. There is a two-pronged problem in the equipment. Either the equipment was outdated and failed to function well or be used easily with other agencies in the case of an emergency where the responders are working together, or the equipment was new and the responders did not understand well enough how to operate it. For example, P2 believed he had sufficient training on radio operability, but he noted, “Each time we switch radio equipment, the sheer number of buttons on my radio can get confusing if you hit the wrong one.” He added that “the newer equipment has become more digitized or synthesized; therefore, increasing its capabilities 10 fold or more." P11 discussed the delays caused by having to report a “man with a gun to the FD dispatch who then had to use radio channels to call the PD dispatch.” By the time they were done with the delays in this system, the man had escaped. In addition, equipment can fail. P15, a small-town law enforcement officer reported, “More than 1 occasion, I have had issues with my portable radio. Not holding a proper charge and dying in the middle stressful situation”.

Even with the national system some participants discussed as a solution, many felt that the local jurisdictions would still need their own channels to avoid so much crowding of signals that information would be lost. P10 complained of not having “enough

equipment or people had different types of equipment to relay information." P10 worked in another major city in California and saw the same issues. He complained that there were times he had to use his "own cell phone and there have been times when [he had] used the cell phones of others on scene to contact other officers or agencies for equipment." Rural officers can have deeper problems than those in small towns and big cities that can generally rely on cell phone coverage. The former struggle with both outdated equipment and not being able to call on their phones due to the many dead areas that exist in a terrain that consists of large mass of land and divided population. Even in a small town or in a big city, however, there are dead spots in buildings and alleys that can prohibit communication interoperability.

Research Question 2

Research Question 2 addressed the triple threat of the role that budget and training play in lack of communications interoperability and the policies that might be instituted to improve the safety of first responders. It also asked what policies might work to improve first responder safety. Of the responses from the 18 participants, budget was mentioned 29 times, policy 35 times, and training 49 times. Many of the miscellaneous issues mentioned 51 times included issues with equipment related to the first research question, but comments on how budget, policy, and training interplayed with equipment challenges were also brought up in the miscellaneous category.

Many of the problems regarding lack of communications interoperability were related to money. Even though the agencies had different types of budgets from taxes or government grants, equipment was not always prioritized, and when it was, there was

generally inadequate training on it. While some participants thought their equipment worked well for them, most believed that budget played a role, particularly in small towns and rural areas because they have a lack of money in areas with low tax bases. P9 in a small town law enforcement agency said that "unfortunately this is often a monetary issue which our small-town agency cannot afford better equipment".

Even in the big cities monetary problems arise that "drain the resources, and basic needs such as communication suffer...but who is ultimately going to pay for this?" according to P10, a law enforcement officer in a large city in California. She added that there was one time that they [her department] "requested for more radio equipment, but a few days after that, other situations arose and some of our secondary communication forms were taken back and used in other breaking incidents."

Training, as mentioned, was the topic discussed with the most frequency. A few participants were happy with their level of training. P10, the city law enforcement officer said that she felt she was adequately trained on the equipment. P16, the firefighter from a small town in California also felt adequately trained on the equipment and that they had "training and we have follow-up professional development." Although it was noted that P12 did feel adequately trained, however. This big city firefighter acknowledged that though properly trained, when he arrived on the scene, he "knew more assistance would be needed...we were all required to complete training on the equipment; however, this equipment only works for those within my department." He added, "No one else within the state has this type of radio communication equipment." While it's advantageous to have the latest technologies, if no one else can communicate with you on it, it becomes

useless as the previously used archaic radio communications systems that was replaced. So, essentially, it becomes trading one ineffective piece of equipment with a new piece of ineffective equipment.

Many of the participants complained that they needed more classroom training rather than training on the job. Although on-the-job training has its benefits, an emergency that can threaten injury and death is hardly a time to learn a new skill. Still, P15 advocated for mock drills, which are entirely different and would provide much needed training. This small-town law enforcement officer said, “At my level, and my peers, we are provided training, however, we are limited by the capabilities of our radios which means, I can work my own radio, and I believe I know who I can talk to.” Thus, he recommended that "this whole situation can be improved by having a mock-drill and scenario-based training, which could help this.”

P2, a big-city law enforcement officer, the one who complained about the confusing updated equipment, emphasized more visual, creative training: “I believe our agency the equipment is adequate, but again you need to have a flow chart to understand who you can talk to when and where…it’s very confusing if you’re not experienced with it." He noted a time when "the situation I experienced was because my radio switched to a different bank/frequency and I was not aware of it." Lack of training can have tragic results and some of the participants emphasized the importance of being well-trained to avoid dangerous situations and liability issues. The participants agreed that when new equipment and policies come out, and then training has to follow so all three are coordinated.

Good policies can help to address almost all lack of communications interoperability issues. Many participants mentioned having a national communications policy, but that would not be without its own problems. They still felt a need to have local channels open and coordinated training. P1, a small-town firefighter in New York stated, “A national system would be great, but budget and affordability would place a huge role in the ability to make that happen. Also, you would have to provide the same training across the board to everyone." P11, a firefighter from a rural area emphasized, “I do not believe it will work as there is too much traffic on single agency channels as it is. The increase in traffic would be too large and no communications can be effective in that way.” She explained, “There is too much traffic on local channels as it is now. So a national system would lead to added confusion and be counter-productive."

Participants complained about the lack of coordination among agencies during disasters. P18 noted the following:

> Our policy is sufficient for our agency and operations. But, I believe that this issue involves other agencies as well (how we interact, how we keep channels current, how we keep access to each other, etc.) and since each agency has its own unique policy, little headway can be made unless these policies are coordinated, especially when it comes to encryption.

Two other policies were related to vehicle equipment as being inadequate and the need to use plain talk rather than 10-code signals. P5, a firefighter in a large city complained about policy related to equipment and how it “varies from position to position.” He added that the Battalion Chiefs have repeaters in their vehicles but no one

else does so radio use varies depending on the type of call." The plain talk issue was conveyed by P15, a small-town law enforcement officer who dealt with language issues in his jurisdiction: "I think [this policy can be improved by *using plain talk* as a policy instead of the ten-code and signals we use. There aren't any more stressful situations than not knowing whether or not backup is coming or if anyone heard your call for help."

Evidence of Trustworthiness

Credibility

In order to enhance credibility, I shared the transcribed interviews with the participants to confirm the accuracy of their words and individual perceptions. None of the participants objected to anything in the transcriptions. Answers were sufficiently detailed to not ask further probing questions, for all of the participants had shared that they were motivated to share their experiences with lack of radio interoperability toward the need to communicate during disasters and routine emergencies where lives may be at stake.

Transferability

The external validity of the study, or transferability, was established when rich descriptions were shared about the participants' experience regarding lack of communication interoperability during emergencies. To seek variation in participant selection, I selected participants not only from the three most populous states in the United States, but they were also split evenly between firefighters and law enforcement personnel in three different settings consistent across the state. The settings were urban, rural, and small town fire and law enforcement agencies.

Dependability and Confirmability

The reflexive analytical strategy that I used aided dependability and confirmability because I was engaged in listening to intonation and pauses during the telephone interviews and making observations of body language in the face to face interviews. During all of the telephone and face-to-face interviews, I took notes by hand in a journal to also track daily activities and methods along with bracketing to minimize bias (Lincoln & Guba, 1985). In the journal, I jotted down any thoughts, ideas, or attitudes I encountered during the telephonic and face-to-face interviews.

Summary

Using a wide variety of participants in two forms of first response from three different regions of the United States and in cities, small towns and rural areas provided a surprising uniformity in response. For the first research question, the participants uniformly agreed that lack of communications operability, especially via the radio was a barrier in serving and protecting the public. Moreover, few were satisfied with their budgets. Even the ones who felt their training was adequate knew that it did not extend to emergency situations where coordination of different agencies is key. All of the participants had suggestions for policies that can improve the way they carry out their jobs. Chapter 5 presents the connection of the findings to the literature as well as the conclusions and recommendations for this study.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this basic qualitative study was to explore ways, as reported by first responders, to effectively ensure their safety on reliable emergency communications, primarily through radio (either directly or via a network). The study was based on the premise that such reliable, fail-safe communications interoperability depends on training, budget, and policy. The qualitative research method employed was a basic qualitative study where the participants recounted their lived experiences regarding lack of radio interoperability when property and lives were at stake as well as the role of policy, training, and budget in connection with such interoperability. Specifically, the study involved semistructured interviews conducted with firefighters and law enforcement officers from California, New York, and Texas. These first responders, who had between 10 and 30 years in their professional roles, presented first-hand depictions of the kinds of dangers with which they were faced in overcoming a condition of failed communications interoperability during natural or human-made disasters.

Although the participants were drawn from both firefighting and law enforcement, and they came from three large states on opposite coasts and on the border of Mexico, their responses were mostly uniform. Together, they agreed that lack of communications operability, particularly via the radio, was a barrier in serving and protecting the public. Most first responders reported that their budgets and their training were inadequate and those who did believe the latter were enough, it rarely extended to emergencies. All of them noted ways to improve their situations with better policies.

Interpretation of Findings

The literature gap is in lack of communication interoperability during mass crises involving catastrophic events like wildfires and floods and drought as well as lawlessness and acts of terror involving humans (National Centers for Environmental Information, 2016). The literature on this issue is scant and those that address communication crises during a disaster when multiple agencies are called in to work together during natural disasters and human crises are almost nonexistent, particularly regarding radio interoperability. There are almost no academic studies on lack of radio interoperability as such (directly addressing lack of radio interoperability in a disaster) other than Huyck (2013, 2014) and professional literature (Timmons, 2007).

More studies have been published on difficulties in communication in emergencies and the findings do corroborate with the general concept of challenges arising from lack of communication interoperability found all over the world (e.g., Fabac et al., 2013; Fu et al., 2012; Klappa et al., 2013; Simon et al., 2014). After an exhaustive literature search, no studies encompassed not only the lack of communications interoperability but its ties to budget, public policy, and training. Therefore, this study can fill a gap in the literature and contribute to positive social change in which public policies that promote adequate budgets and comprehensive training can help to ensure seamless communications interoperability to prevent personal injuries and fatalities in the line of duty.

Overall, the findings not only confirmed the challenges of maintaining radio interoperability but also extended the knowledge and experience that first responders

have over many years of experience. All 18 of the participants found problems in communicating, whether in large buildings in urban areas (P1, a New York firefighter with experience in other locations complained about how building construction can hamper interoperability among first responders); in rural areas (P13, a law enforcement officer in rural Texas noted that despite the many repeater systems they need in the country, there are places that simply have no coverage even for cellphone backup if radios cannot communicate); or in small towns (P9, a small town California law enforcement officer complained that even with good equipment, the signal is simply not strong enough at all times).

After the research was conducted and the findings revealed, I did a thorough search for articles that have come out in the past 5 years that may have been overlooked by varying combinations of original search terms for lack of radio or communication interoperability. Fourteen new peer-reviewed studies were located in a broad emergency management category. However, only three touched on the topic of interoperability (Cantwell & McDermott, 2016; Nelson, 2014; Nowell & Steelman, 2015). The other studies were mostly based on equipment and training, particularly looking toward the future: robotic deployment for disasters (Min, Kim, Lee, Jung, & Matson, 2016); alternatives for radios including expanded use of social media (Murphy, 2013); a system of aircraft piloted remotely for major disasters (Abrahamsen, 2015); mobile government services (Aloudat, Michael, Chen, & Al-Debei, 2014); interoperability during disaster recovery (Minh, Shibata, Borcea, & Yamada, 2016); and amateur radio operators helping to expand communication options (Nollet & Ohto, 2013).

Lack of communication interoperability permeated the themes and how budget, training, and policy affected the participants' experiences when they could not communicate with other jurisdictions during a crisis. The subthemes that arose directly from lack of interoperability are (a) lack of communication interoperability costs lives, (b) poor radio transmission due to variations in equipment, (c) having to result to personal and others' cellphones, d) difficulty communicating in large buildings, (e) dependency on own dispatch in lieu of interoperability with other agencies, and (f) large land mass in rural areas with sporadic coverage.

The triple threat of budget and training and the policies that govern these critical areas of communication were confirmed by almost all of the participants. Regarding budget, many of the problems within interoperability stem from not having the funding to buy sufficient or updated equipment often as a result of improperly allocated or inadequate budgets. Huyck (2015) emphasized that if technological networks are expanded, it takes more than training and policy but also adequate budgets to cover the unfunded state and federal mandates. Larger organizations have more funding compared to smaller agencies (citation), yet more funding does not necessarily lead to having state-of-the-art equipment, especially when situations emerge where the money has to be reallocated. Subthemes that could be connected to budget were (a) equipment update delays due to emergency budget priorities and (b) lack of money in small towns and rural areas. P8, a firefighter from a small town in Texas, brought up both subthemes when he acknowledged that while nonurban areas do get grants from the government for equipment, the money often ends up being prioritized for vehicles and other fire

equipment. Though they are aware of more advanced systems, money rarely goes for radio equipment. Further, their grants get smaller every year.

P16, a small town firefighter in California noted that his work is done off a radio system that the department has used for 4 years, and he knows about other systems that could serve their needs better but he had no knowledge of when a new system "will be allotted to [them]." He felt that there was no communication from his superiors if and when they would be obtaining new equipment and did not know if they even had the "financial resources to move ahead with a new radio system or other types of equipment." Even when there is adequate money budgeted for new equipment, there can be problems. P12, for example, an urban California firefighter, complained that despite the fact he and his colleagues were trained on the new system, they had no idea about its nature, they were not able to choose a new system themselves, and importantly, they had no knowledge if anyone else in the state had the same equipment, which corroborates the problem of lack of radio interoperability because there were no uniform equipment standards. Thus, during a disaster, they would not be able to rely on being able to communicate with other teams.

Though some first responders were satisfied with their equipment, they feel they "would have been better prepared if [they] had direct communications with the other fire department that was already on the scene" (P14, rural California firefighter). P14 did feel confident their equipment was adequate for them but cautioned, "What we need is a system that works with other fire departments within our state … I'd like to know if we have the financial resources to obtain equipment that talks with other fire departments in

state." P15, a small town law enforcement officer in Texas has had good experiences with their "relatively dated equipment" but speculated that "if a major incident ever did occur," they would not "be able to communicate with mutual aid assistance from other jurisdictions with newer equipment and on different frequencies." Furthermore, P13, a rural Texas law enforcement officer related that what stood out the most regarding lack of communication interoperability was that he "can't safely serve because of the communication interoperability," which relates not only to budget but also to public policy.

Policy subthemes, either regarding local rules and procedures, between agencies, or from government either actual or as suggestions arose four times: (a) lack of coordination among agencies, (b) desire for national communication system, (c) vehicle radio equipment inadequate in emergencies, and (d) need for plain talk instead of 10-code and signals. Many of the participants criticized the ineffectual or misapplied governing policies. Policies have been made that first responders should go through the IPAWS process established by FEMA in 2004 with the goal of interoperability between different kinds of responders toward the goals of safety and security (Goldstein, 2013; Leiva, 2014).

However, the GAO (2009) revealed that progress was slow in implementing public policy. P13 saw policy as a safety factor which "creates added danger to an already dangerous situation and backup may be further away than I would need and like." He added that areas that have no coverage are discovered on the job, which tends to make first responders do their "best to say out of those areas for safety reasons" (P13). Baldini

et al. (2013) touted a technology of wireless communication that should work for every agency: the military, corporations, and public safety. Yet, the researchers noted that policies have to be enforced to allocate the resources including who can access the technology and what resources are available and when and where and how to apply the technology. Baldini et al.'s framework involved negotiating trust so that distributed access policies have to have multiple parties ensuring the access.

Training, or its lack, was discussed by all of the participants. Regarding the frequency with which this topic came up, often in depth, there were 29 mentions of budget, 35 of policy, and 49 of training. Four subthemes arose on training: (a) classroom training needs rather than on-the-job training, (b) lack of training can result in liability issues, (c) lack of training can result in injuries and loss of life, and (d) need for coordination of training with new equipment and policies. Henry (2009) brought up five challenges regarding training, some of which are strongly related to policy: (a) oversight and governance (informal), (b) uncoordinated standard operating procedures, (c) incompatible and obsolete technology, (d) infrequent and inconsistent trainings and exercises, and (e) difficulty integrating interoperability into routine, daily use. The participants brought up each of these challenges in their interview. Although some of the first responders were satisfied with the training they had received, most of them complained about inadequate training. In the case, for example, of those whose departments had purchased new equipment, few felt adequately trained.

As stated previously, for successful communication interoperability, shared management, control, policies, and procedures must be multidisciplinary and

multijurisdictional. There is a significant gap in the literature on lack of radio interoperability. In the scholarly literature, only Huyck (2015) addressed the general problem in the past 10 years. Huyct (2013) also presented a case study involving public safety radio interoperability in a populated county in Illinois. Huyck (2015) emphasized the importance of restructuring policies and legislation as a result of inadequate federal funding, stating, "As it stands, interoperability problems cross-organizationally and jurisdictionally are inherent within the current structure of radio communication among first responders" (p. 22). The literature that Huyck cited is primarily from the GAO and professional publications, but of the articles cited, all recommend more cooperation among agencies. Because the systems cannot communicate compatibly, stronger policies need to be made. Huyck noted that "technological limitations of equipment hardware and cost deliberations over added infrastructure … illuminated operational barriers to the achievement of long-term radio interoperability" (p. 22), a finding that is consistent with the results of the present study. Public policies must be made so that lack of radio interoperability for local agencies will be solved and the necessary resources can be funded (Huyck, 2015).

The conceptual framework of the study was based on three communication theories: Grebner's general model of communication theory; Shannon and Weaver's information theory; and risk communication theory. The findings of the study tied in well with these theories. The main focus of Grebner (1956) was not only on the dynamism of communication but also how it would only be effective if its use involved a consistent method. Grebner noted that the factors that come into play during an event (E) related to

the message (M) are context, selection, and availability all of which are present in emergency management. Consistent communication interoperability during the *context* of a wildfire, for instance, involves selecting a means for one firefighter to be able to talk to another firefighter or another team who may not have the same equipment or channels available to warn them that the wind has changed direction and their lives are in danger. The dimension of means and controls, according to Grebner, necessitates communication with a third party over which the control can vary depending on capability. The message, as in the case of the wildfire, can be complicated through incompatible receivers. Thus, the message may be complicated and lack of interoperability takes over. At every level, communication can be changed or altered (Grebner, 1956).

Shannon and Weaver's work on communication theory involved interpreting human communication (Griffen, 2014). Like the first responders whose main goal was always full communication interoperability, Shannon and Weaver (year) demonstrated through the communications interpretations, that the most important goal is to reduce loss of information. They first theorized about noise, which can disrupt communication flow to the point that the one who should receive the intended message cannot. The stakes are much higher in emergency management; contrary to noise causing problems in everyday communication, property damage, injury, and death can be the result of lack of communication interoperability. Similarly, in risk communication theory, where originally, Fischhoff (1995) discussed managers communicating events involving risks to the public, the theory is now used widely in emergency management for all those in charge of risk control. Coombs (2012) emphasized that failure to control risk effectively

may either lead to a crisis or go the opposite way where a crisis may lead to necessary risk communication, both of which are the main areas that the present study addresses.

Lack of consistency was one of the main problems for all 18 respondents. There were inconsistent budgetary resources; inconsistent, inadequate training even when the responders asked for even the most basic information or more information on operating their equipment; and inconsistent policies from one agency to the other, one state to the other, and from lack of implementation of federal policies. Finally, as stated previously, equipment and training would not be problems if adequate funding, proper budgetary items, and consistent policies were allocated to provide first responders with the life-saving tools they need.

Limitations of the Study

The study participants were limited to first responders who were firefighters and law enforcement officers who had experienced emergency situations in the populous states of California, New York, and Texas. One limitation of the study is that the research was confined to only fighters and law enforcement officers among other emergency responders such as paramedics and other medical personnel. Another limitation is the participants were chosen from three of 47 other U.S. states, yet by spreading the states over a wide geographical range, the limitation was somewhat addressed. A third limitation was that the participants were kept to 18, so my representative sample was small but manageable based on the themes. Still, keeping to the three most populous states gave a higher instance of issues than might have arisen for other regions. The

results from this basic qualitative study could not be generalized to all first responders in all states who have experienced emergencies of disastrous proportions.

It is important to note that two disciplines were used where a lot of similarities and differences between disciplines could be seen and kept the study from getting unwieldy. Because I was unable to go out in the field, I did not have the opportunity to interview face-to-face in two out of three states, but based on the results, the findings were consistent despite the means through which the data were gathered. One clear limitation was that not all departments had the same budgets and were not pulling the funding from the same sources. Small town fight fighters, for instance, had less of a budget than that of a larger agency. Another possible limitation was the criterion of survey participants having to have had at least 10 years of experience in the discipline, which precluded participants who could have added to the study even though they had less experience.

Recommendations

The recommendations for this study are based upon the literature search conducted, the data collected, and the results analyzed, all of which suggest global challenges in addressing lack of radio interoperability. The following recommendations are by no means all inclusive, but rather are within the depth and scope of the parameters of the present study.

Budgets are predetermined by those who dictate policy and allocate funds. Unless there is a dedicated grant writer on staff, funding becomes challenging because it is so difficult to process because of bureaucratic red tape. Time to find financial resources to

further support the initial budget is also limited. Whoever is in involved in budget must understand the process and objectives. If one does not have sufficient knowledge of the recommended or needed equipment, not only will the wrong equipment be purchased but it might not serve the needs of the agency. Therefore, though hiring a grant writer might seem cost-prohibitive in the short term, it is a financially sound decision in the long term. The equipment would have incompatibilities and possibly not be expandable. If grant writers are not available and funds are limited for big-ticket items or upgrading present systems, then the agency can consider various patches to serve as an intermediate means to expand communications interoperability.

Agencies must consider other agencies within surrounding jurisdictions so upgrades are compatible and those who use the equipment can become more knowledgeable and adaptable for future implementation of the equipment. Decisions cannot be made in isolation but rather collaboratively through the use of MOAs and MOUs. Not only is communication critical among agencies for the short term, but also collegial strategic planning is essential for the long-term health and viability of the organization and ultimately the community.

Although several participants mentioned the need for a national network, many agencies are unable to comply because of attitudes, cultures, and beliefs in addition to outdated or incompatible equipment. Further, the impracticality of putting so many first responders on one national network is an important consideration regarding overcrowding and security (e.g., how many people can get on a channel at one time). The statewide patch capabilities and knowing who one can be communicated with are more

understood within a jurisdiction through trial and error and history. Communication is supposed flow to the federal level, but there is training and policy disconnect. Certain federal agencies have capabilities for interoperability but only among themselves.

Communication interoperability is also rooted in technological advances; thus, for communication to occur, agencies need to keep up continuously with technology. The National Association of State Telecommunications Directors, the Association of Public Safety Communication Officials in addition to various federal agencies developed P25 as a universal standard for public safety personnel to ensure compatibility. However, the standards have been significantly vague to the point that manufacturers have not been able to produce sufficiently compatible equipment. Furthermore, compatibility comes with price, which results in agencies having aging, incompatible equipment that fails to lead to interoperability (GAO-07-301, 2007). Therefore, administrators need to be mindful and share ongoing communications with their team to be cognizant of what is happening in regards to the policy. It is apparent that P25 needs to be expanded to include specific language that defies ambiguity.

On September 11, 2001 during the terrorist attacks on the World Trade Center, the NYPD repeaters were on the top of one of the two buildings. Thus, system redundancy is needed in the case of a major system going down to keep interoperability. A policy has already been established in the National Interoperability Field Operations Guide (NIFOG) from the U.S. Department of Homeland Security, Office of Emergency Communications (2011). Personnel who are tasked with programming and maintaining communications equipment for their organization should be given this guide as a means

to program the channels for federal communications interoperability. The stipulation is that it cannot be used for anything other than federal communications. A federal agency must be involved. However, the guide points to multiple bandwidth accessibility for nonfederal interoperability channels. It is recommended that those in administrative or training role be given this guide to communicate appropriate functions to those in the day-to-day practices of emergency management. As stated in the manual,

> The NIFOG may be used by radio technicians when programming channels in radios. We recommend having these channels programmed in radios at all times, as permitted by the applicability regulations, rather than waiting until a disaster is imminent or occurring to do the programming. (p. 3)

The DHS claims that the NIFOG is an appropriate tool to be used by emergency communications planners so they will have enough information on channels of interoperability to know what they will encounter in the radios of their colleagues from other jurisdictions or disciplines. Because the allocation of radio waves defines a small segment of bandwidth, bandwidths are split (bandwidth frequency allocations). Certain needs for various locations are situation specific and; therefore, must be determined as part of policy, even within a given state.

Implications

The adage about a parent having to put his/her oxygen mask on before assisting the child's oxygen mask in an emergency also applies to first responders. Best practice teaches first responders that they come first, then the victims, and finally the suspects. Personal preparedness is key to managing an emergency. When firefighters and law

enforcement officers have needed radio interoperability, they have fewer barriers in fulfilling their duties in protecting the people they serve than if radio interoperability is lacking.

The implication for social change within an organization is increased productivity as well as the ability to communicate with other agencies so that each entity can carry out their purpose efficiency.

The implications for social change for society are that shared digital trunked systems increase interoperability and expand coverage for greater flexibility among users. Providing that various agencies are in alignment with one another, standards are improved and compliance issues are minimized.

The community can perpetuate social change once awareness is established. Without communication of budgetary needs, for example, negative consequences can result for local agencies. Community awareness and involvement can lead to both short-term help and long-term solutions.

In searching for patch capabilities, it is cost effective to utilize these options as opposed to alienating current systems in exchange for cutting edge technology that may not be compatible or in alignment with nearby jurisdictions. Although patching may seem like too simple a solution, such an alternative may provide the short-term assistance that is crucially needed for organizational success. Because much of the new equipment is digital, it might be expanded at a later date to other bands.

When policies are delineated among jurisdictions, the benefits for future interoperability are improved. Once the policies are transparent, they let agencies

understand the intentions are of obtaining and maintaining communications systems, and there can be more standardization among jurisdictions.

Policies on state and national levels can provide greater articulation so that everyone will be in better alignment. In interoperability, prevention is positive. It keeps everyone in alignment in preparation for a response.

If the grant process is continued, then everyone needs to be aware of how interoperability can be coordinated for proper response. Local agencies are often reluctant to share their frequency lineups for compatibility reasons. Thus, people are unaware of this issue ("You cannot talk to everybody you want to?"). This study can help raise community awareness to promote the objectives of communication interoperability.

Conclusions

This study confirmed the need for those in the emergency services field to have a finite, transparent, and consistent policy regarding communication interoperability for personnel to effectively save lives without compromising their own personal safety in the process. The indices of budget, policy, and training demonstrated a marked outcome in carrying out this study of the experience of first responders in addressing lack of communication interoperability.

While there is almost always the need for more money across agencies to fund compatible radio equipment, grant writers can be obtained to seek and apply for additional funds as needed. Additionally, should a grant writer not be a viable option, then the specific organization can make outreach to the community in an attempt to further promote their cause. Policy needs to be consistently managed through assessment

and updates, to be revisited, to ensure it is meeting the needs of the agency, of the user and of the community that it serves. Even though training is required, whether it is through formal instruction or on-the-job experience, consistent, ongoing training is vital because of its fluidity.

References

Abrahamsen, H. B. (2015). A remotely piloted aircraft system in major incident management: Concept and pilot, feasibility study. *BMC Emergency Medicine*, *15*(1), 1-12. doi:10.1186/s12873-015-0036-3

Aloudat, A. A., Michael, K., Chen, X., & Al-Debei, M. M. (2014). Social acceptance of location-based mobile government services for emergency management. *Telematics & Informatics*, *31*(1), 153-171.

Anthony, K. E., Cowden-Dodgson, K. R., O'Hair, D. H., Heath, R. L., & Eosco, G. M. (2014). Complexities in communication and collaboration in the hurricane warning system. *Communication Studies*, *65*, 468-483. doi:10.1515/jhsem-2014-0074

Atkinson, C. C. (2014). Crisis communication in dark times: The 2011 Mouse River Flood in Minot, North Dakota. *International Journal of Communication*, *8*, 1394-1414. Retrieved from Social Sciences Full Text. Accession No. 97264424**.**

Atkinson, D. J., & Catellier, A. A. (2008, June). *Intelligibility of selected radio systems in the presence of fireground noise: Test plan and results* (NTIA Technical Report TR-08-453). Retrieved from United States Department of Commerce, National Telecommunications and Information Administration website: http://www.its.bldrdoc.gov/publications/08-453.aspx

Atkinson, R., & Flint, J. (2001). Accessing hidden and hard-to-reach populations: Snowball research strategies. *Sociology Research Update*, *33*. Guildford, UK: University of Surrey. Retrieved from http://sru.soc.surrey.ac.uk/SRU33.pdf

Baldini, G., Fovino, I. N., Braghin, S., & Trombella, A. (2013). Distributed access control policies for spectrum sharing. *Security & Communication Networks*, *6*, 925-935. doi:10.1002/sec.629

Barthel, B. A. (2012). 9/11 ten years after: Command, control, communications remain issue. *Strategic Research Project*. U.S. Army War College. Retrieved from https://www.ntis.gov/

Bertrand, E. (2012). Constructing Russian power by communicating during disasters: The forest fires of 2010. *Problems of Post-Communism*, *59*(3), 31-40. doi:10.2753/PPC1075-8216590303

Bilve, A., Nogareda, F., Joshua, C., Ross, L., Betcha, C., Durski, K., … Nilles, E. (2014). Lessons from the field: Establishing an early warning alert and response network following the Solomon Islands tsunami in 2013. *Bulletin of the World Health Organization*, *92*(August), 844-848. doi:10.2471/BLT.13.133512

Brengarth, L. l., & Mujkic, E. E. (2016). WEB 2.0: How social media applications leverage nonprofit responses during a wildfire crisis. *Computers in Human Behavior*, *54*, 589-596. doi:10.1016/j.chb.2015.07.010

Brito, J. (2007). Sending out an S.O.S.: Public safety communications interoperability as a collective action problem. *Federal Communications Law Journal*, *59*(3). Retrieved from http://jerrybrito.com/pdf/59FedCommLJ457.pdf

Broomé, R. E. (2013). The lived-experience of leading a successful police vehicle pursuit: A descriptive phenomenological psychological inquiry. *Journal of Phenomenological Psychology*, *44*(2), 220-243.

Budka, K. C., Chu, T., Doumi, T. L., Brouwer, W., Lamoureux, P., & Palamara, M. E. (2011). Public safety mission critical voice services over LTE. *Bell Labs Technical Journal (John Wiley & Sons, Inc.)*, *16*(3), 133-149. doi:10.1002/bltj.20526

Burtness, P. S., & Ober, W. U. (2013). Communication lapses leading to the Pearl Harbor disaster. *Historian*, *75*, 740-759. http://doi.org/10.1111/hisn.12019

Cantwell, E., & McDermott, K. (2016). Making technology talk: How interoperability can improve care, drive efficiency, and reduce waste. *Healthcare Financial Management*, *70*(5), 70.

Chan, Z. C. Y., Fung, Y.-L., & Chien, W.-T. (2013). Bracketing in phenomenology: Only undertaken in the data collection and analysis process? *The Qualitative Report*. Retrieved from http://www.nova.edu/ssss/QR/QR18/chan59.pdf

Changing Minds. (2016). SMCR model. Retrieved from http://changingminds.org/disciplines/communication/models/smcr.htm

Comfort, L. K. (2012). Designing disaster resilience and public policy: Comparative perspectives. *Journal of Comparative Policy Analysis: Research and Practice*, *14*(2). doi:10.1080/13876988.2012.664709

Coombs, W. T. (2012). *Ongoing crisis communication: Planning, managing, and responding* (3rd ed.). Thousand Oaks, CA: Sage.

Creswell, J. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Los Angeles, CA: Sage.

Damianakis, T., & Woodford, M. R. (2012). Qualitative research with small connected communities: Generating new knowledge while upholding research ethics. *Qualitative Health Research*, *22*, 7080718. doi:0.1177/1049732311431444

Davis, G. L., & Robbin, A. (2015). Network disaster response effectiveness: The case of ICTs and Hurricane Katrina. *Homeland Security & Emergency Management*, *12*, 437-467. doi:10.1515/jhsem-2014-0087

Denzin, N. K. (2012). Triangulation 2.0. *Journal of Mixed Methods Research, 6*(2), 80-88. doi:10.1177/1558689812437186 0

Denzin, N. K., & Lincoln, Y. S. (2011). *The Sage handbook of qualitative research* (4th ed.). Thousand Oaks, CA: Sage.

Department of Homeland Security. (2008). National emergency communications plan. Retrieved from www.dhs.gov/xlibrary/assets/national_emergency_communications_plan.pdf

Department of Homeland Security. (2011). National interoperability field operations guide (version 1.4). Retrieved from http://www.safecomprogram.gov/SAFECOM/nifog

Ewart, J., & Dekker, S. (2013). Radio, someone still loves you! Talkback radio and community emergence during disasters. *Continuum: Journal of Media & Cultural Studies*, *27*, 365-381. doi:10.1080/10304312.2013.772106

Fabac, R., Đalog, D., & Zebić, V. (2015). Organizing for emergencies: Issues in wildfire fighting in Croatia. *Interdisciplinary Description of Complex Systems*, *13*(1), 99-116. doi:10.7906/indecs.13.1.11

Federal Emergency Management Agency. (2009). Emergency alert system. Retrieved from http://www.fema.gov/emergency-alert-system

Fernandez, M. E., Breen, L. J., & Simpson, T. A. (2014). Renegotiating identities: Experiences of loss and recovery for women with bipolar disorder. *Qualitative Health Research*, *24*, 890-900. doi:10.1177/1049732314538550

Fischhoff, B. *(*1995*).* Risk perception and communication unplugged: twenty years of process. *Risk Analysis*, *15*(2), 137-145. Retrieved from http://sds.hss.cmu.edu/risk/articles/unplugged.pdf

Foley, G., & Timonen, V. (2015). Using grounded theory method to capture and analyze health care experiences. *Health Services Research*, *50*, 1195-1210. doi:10.1111/1475-6773.12275

Frankfort-Nachmias, C., & Nachmias, D. (2008) *Research methods in the social sciences* (7th ed.). New York, NY: Worth.

Fu, K., Zhou, L., Zhang, Q., Chan, Y., & Burkhart, F. (2012). Newspaper coverage of emergency response and government responsibility in domestic natural disasters: China-US and within-China comparisons. *Health, Risk & Society*, *14*(1), 71-85. http://doi.org/10.1080/13698575.2011.641521

Goldstein, M. (2013). Capabilities have improved, but additional guidance and testing are needed. *GAO Reports*, 45 p. Retrieved from http://www.gao.gov/assets/660/654135.pdf

Government Accountability Office. (2007). First responders: Much work remains to improve communications interoperability (Publication no. GAO-07-301). Washington, DC: U.S. Government Printing Office; GAO-07-301.

Government Accountability Office. (2009). Emergency preparedness improved planning and coordination necessary for modernization and integration of Public Alert And Warning System. (Publication no. GAO-09-834). Washington, DC: Government Printing Office; GAO-09-834. Retrieved from http://www.gao.gov/new.items/d09834.pdf

Government Accountability Office. (2011). Emergency communications: Vulnerabilities remain and limited collaboration and monitoring hamper federal efforts. *Journal of Communications Research*, *3*, 481-545. Retrieved from Communication & Mass Media Complete. Accession No. 86710482

Graham, D. A. (2015, September 15). Just how bad is the 2015 fire season? Drought and climate change have combined to produce the largest area burned in more than a decade. *The Atlantic*. Retrieved from http://www.theatlantic.com/national/archive/2015/09/just-how-bad-is-the-2015-fire-season/405439/

Grebner, G. (1956). Toward a general model of communication. *Audio-Visual Communication Review*, *4*(3), 171-199. Retrieved from web.asc.upenn.edu/gerbner

Griffen, E. (2014). *A first look at communication theory (conversations with communication theorists)* (9th ed.). New York, NY: McGraw-Hill Education.

Haque, U., Hashizume, M., Kolivras, K. N., Overgaard, H. J., Das, B., & Yamamoto, T. (2012). Reduced death rates from cyclones in Bangladesh: What more needs to be done? *Bulletin of the World Health Organization*, *90*(2), 150–156. http://doi.org/10.2471/BLT.11.088302

Hardie, K., & Kitchen, T. (2014). Operation Crash and Surge: Lessons learned from a region-wide exercise. *Journal of Business Continuity & Emergency Planning*, *7*, 302-311. Retrieved from International Security & Counter Terrorism Reference Center. Accession No. 96735908

Hawkins J. (2013). Will all government services take a cloud first approach? *The Guardian*. Retrieved from http://www.theguardian.com/media-network/media-network-blog/2013/mar/07/cloud-public-sector-government

Hayes, J. (2015). Taking responsibility for public safety: How engineers seek to minimise disaster incubation in design of hazardous facilities. *Safety Science*, *77*, 48-56. doi10.1016/j.ssci.2015.03.016

Hazlett, T. W., & Ohn, S. (2013). Exactitude in defining rights: Radio spectrum and the "harmful interference" conundrum. *Berkeley Technology Law Journal*, *28*, 227-339. Retrieved from Communication & Mass Media Complete. Accession No. 71795393

Henry, D. (2009). Advancing public safety interoperable communications: Recent state actions. *NGA Center for Best Practices*: *Issue Brief*. Washington, DC: NGA Center. Retrieved from http://www.nga.org/files/live/sites/NGA/files/pdf/0906advancingpublicsafety.pdf

Henry, D. (2012). Improving preparedness through sharing public health and homeland security information. National Governor's Association. Retrieved from CommHenry2012InteragencyStateGov.pdf

Hofmeyer, A., Scott, C., & Lagendyk, L. (2012). Researcher-decision-maker partnerships in health services research: Practical challenges, guiding principles. *BMC Health Services Research, 12*, 280-285. doi:10.1186/1472-6963-12-280

Holmberg, M. I. (2014). To surrender in dependence of another: The relationship with the ambulance clinicians as experienced by patients. *Scandinavian Journal of Caring Sciences*, *28*(3), 544-551.

Hu, Q., Knox, C. C., & Kapucu, N. (2014). What have we learned since September 11, 2001? A network study of the Boston Marathon bombings response. *Public Administration Review*, *74*, 698-712.

Hunter, J. C., Yang, J. E., Petrie, M., & Aragón, T. J. (2012). Integrating a framework for conducting public health systems research into statewide operations-based exercises to improve emergency preparedness. *BMC Public Health*, *12*, 680–689. http://doi.org/10.1186/1471-2458-12-680

Hutchins, S. G., & Timmons, R. P. (2007). Radio interoperability: There is more to it than hardware. Human Factors and Ergonomics Society Annual Meeting Proceedings 05/2007; 50(4):28. doi:10.1177/154193120605000413

Huyck, N. L. (2013). Exploring public safety radio interoperability within a metropolitan county of southwestern Illinois: A case study evaluation. *International Journal of Business & Public Administration, 10*, 121-134. Retrieved from Business Source Complete. Accession No. 91955992

Huyck, N. L. (2015). Interoperability challenges among public safety radio systems: Surveyed research addressing these challenges. *International Journal of Business & Public Administration*, *12*(1), 12-24. Retrieved from Business Source Complete. Accession No. 110096430

Insinna, B. Y. V. (2013). Natural disasters uncover ongoing emergency communications problems. *National Defense*, 36-37.

Kawasaki, A., Berman, M. L., & Guan, W. (2013). The growing role of web-based geospatial technology in disaster response and support. *Disasters*, *37*(2), 201-221. doi:10.1111/j.1467-7717.2012.01302.x

Kehl, D., Knuth, D., Galea, E., Hulse, L., Sans, J., Valles, L., & ... Schmidt, S. (2014). Advancing disaster relief: Development of a self-report questionnaire for firefighters. *International Perspectives in Psychology: Research, Practice, Consultation*, *3*(3), 167-183. doi:10.1037/a0036423

Klappa, S., Audette, J., & Do, S. (2014). The roles, barriers and experiences of rehabilitation therapists in disaster relief: Post-earthquake Haiti 2010. *Disability And Rehabilitation*, *36*, 330-338. doi:10.3109/09638288.2013.791726

Kożuch, B., Małyjurek, K. S.-, & Kożuch, A. J. (2015). Communication in local emergency management networks (part 2). Effective communication as a basis for appropriateness. *International Journal of Contemporary Management*, *14*(1), 91-104.

Kryvasheyeu, Y., & Chen, H. (2014). Performance of social network sensors during Hurricane Sandy. *PLoS ONE*, 1-19. doi:10.5061/dryad.15fv2

Lal, S., Suto, M., & Ungar, M. (2012). Examining the potential of combining the methods of grounded theory and narrative inquiry: A comparative analysis. *The Qualitative Report*, *17*(Art.41), 1-22.

Leiva, M. (2014). Leveraging emergency notification alerts. *Homeland Security Affairs*, *10*, Article 5. Retrieved from https://www.hsaj.org/articles/263

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage Publications

Liotine, M., Howe, J., & Ibrahim, D. A. (2013). Regional public-private interoperable communications for catastropic events using a loud computing based portal. *Journal of Homeland Security & Emergency Management*, *10*(1), 1-20. doi:10.1002/bltj20525

Magnuson, S. (2012). High-altitude balloons, unpiloted aircraft seen as answer to emergency communication outages. *Homeland Security News*. Retrieved from http://www.nationaldefensemagazine.org/archive/2012/august/pages/high-altitudeballoons,unpilotedaircraftseenasanswertoemergencycommunicationoutages.aspx

Martinez, B. R. (2014). Mobilization training: Long Island USAR training. *Fire Engineering*, *167*(10). Retrieved from http://www.fireengineering.com

McCusker, K., & Gunaydin, S. (2015). Research using qualitative, quantitative or mixed methods and choice based on the research. *Perfusion*, *30*, 537-542. doi:10.1177/0267659114559116

McEntire, D. A. (2007). *Disciplines, disasters, and emergency management*: *The convergence and divergence of concepts, issues and trends from the research literature*. Springfield, IL: Charles C. Thomas.

McGee, A. R., Coutière, M., & Palamara, M. E. (2012). Public safety network considerations. *Bell Labs Technical Journal (John Wiley & Sons, Inc.)*, *16*(3), 133-149. doi:10.1002/bltj.20526

McQuail, D. (2010). *McQuail's mass communication theory* (6th ed.). London, UK: Sage.

Mendonça, D., Webb, G., Butts, C., & Brooks, J. (2014). Cognitive correlates of improvised behaviour in disaster response: The cases of the Murrah Building and the World Trade Center. *Journal of Contingencies & Crisis Management*, *22*(4), 185-195.

Merriam, S. G., & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation* (4th ed.). New York, NY: John Wiley & Sons.

Min, B. M., Kim, Y. K., Lee, S. l., Jung, J. J., & Matson, E. E. (2016). Finding the optimal location and allocation of relay robots for building a rapid end-to-end wireless communication. *Ad Hoc Networks*, *39*, 23-44.

Minh, Q. G., Shibata, Y. S., Borcea, C. B., & Yamada, S. S. (2016). On-site configuration of disaster recovery access networks made easy. *Ad Hoc Networks*, *40*, 46-60.

Minnis, P. (2013), Linear contrail and contrail cirrus properties determined from satellite data, *Geophysicist Research Letter, 40*, 3220-3226, doi:10.1002/grl.50569

Moore, L. K. (2011). Public safety communications and spectrum resources: Policy issues for Congress. *Journal of Communications Research*, *2*(2/3), 149-177. Retrieved from Communication and Mass Media Complete. Accession No. 71795392

Moore, L. K. (2013). Spectrum policy in the age of broadband: Issues for Congress. *Journal of Current Issues in Media & Telecommunications*, *5*, 353-373. Retrieved from Communication & Mass Media Complete. Accession No. 95780765

Moore, L. K. (2015). The First Responder Network (FirstNet) and Next-Generation Communications for Public Safety: Issues for Congress. *Congressional Research Service*: *Report 2/27/2015 Preceding*, 1-23. 26 p. Retrieved from International Security & Counter Terrorism Reference Center. Accession No. 103301316

Mountjoy, J. J. (2005). Broken connections. *State News* (Council of State Governments), *48*(9), 34. Retrieved from Ebsco. Accession No. 18566435

Murphy, M. M. (2013). Social media and the fire service. *Fire Technology*, *49*(1), 175-183.

National Aeronautics and Space Agency. (2015, August 26). Pacific Northwest wildfires severe in intensity. Retrieved from http://www.nasa.gov/image-feature/goddard/pacific-northwest-wildfires-severe-in-intensity

National Institute for Occupational Safety and Health. (2015). Division of Safety Research. Map. Retrieved from http://wwwn.cdc.gov/wisards/fffmap

National Oceanic and Atmospheric Administration, National Centers for Environmental Information. (2016). Billion-dollar weather and climate disasters: Summary stats. Retrieved from https://www.ncdc.noaa.gov/billions/summary-stats

National Public Safety Telecommunications Council. (2016). Retrieved from http://www.npstc.org/

National Task Force on Interoperability. (2005). *Why can't we talk: Working together to bridge the communications gap to save lives. A guide for public officials*. Washington, DC: National Task Force on Interoperability. U.S. Department of Justice, Office of Justice Programs.

Nelson, R. (2014). Radio technologies ready for emergencies. *EE*: *Evaluation Engineering*, *53*(5), 18-19.

Nollet, K. E., & Ohto, H. (2013). When all else fails: 21st century Amateur Radio as an emergency communications medium. *Transfusion & Apheresis Science*, *49*, 422-427. doi:10.1016/j.transci.2013.08.002

Nowell, B., & Steelman, T. (2015). Communication under fire: The role of embeddedness in the emergence and efficacy of disaster response communication

networks. *Journal of Public Administration Research & Theory*, *25*, 929-952. doi:10.1093/jopart/muu021

Oliver, W. M., & Meier, C. A. (2016). The four stress factors unique to rural patrol revisited. *The Police* Chief, *1120*(04). Retrieved from http://www.policechiefmagazine.org/

Opdenakker, R. (2006). Advantages and disadvantages of four interview techniques in qualitative research. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 7*(4). Retrieved from http://www.qualitative-research.net/index.php/fqs/article/view/175/392

Oxendine, C., Sonwalkar, M., & Waters, N. (2012). A multiobjective, multicriteria approach to improve situational awareness in emergency evacuation routing using mobile phone data. *Transactions in GIS*, *16*, 375-396. doi:10.1111/j.1467-9671.2012.01341.x

Peterson, M. F., & Sondergaard, M. (2011). Traditions and transitions in quantitative societal culture research in organization studies. *Organization Studies*, *32*, 1538-1558. doi:10.1177/0170840611421255

Petty, N. J., Thomson, O. P., & Stew, G. (2012). Ready for a paradigm shift? Part 1: Introducing the philosophy of qualitative research. *Manual Therapy*, *17*, 267- 274. doi:10.1016/j.math.2012.03.006

Piotrowski, C. (2013). Disaster research for the Hurricane Sandy impact area: A select bibliography. *Journal of Instructional Psychology*, *39*(3), 192-196. Retrieved from

https://www.academia.edu/8567424/More_Than_A_Storm._The_Kean_Experience_With_Hurricane_Sandy_and_Lessons_Learned

Revere, D., Calhoun, R., Baseman, J., & Oberle, M. (2015). Exploring bi-directional and SMS messaging for communications between public health agencies and their stakeholders: A qualitative study. *BMC Public Health*, *15*(1), 1-13. doi:10.1186/s12889-015-1980-2

Ristoska, Z., & Gjurov, L. (2014). The importance of public relations and communications training during crisis. *Contemporary Macedonian Defense*, *14*(26), 87-98. Retrieved from International Security & Counter Terrorism Reference Center. Accession No. 110468250

Shannon, C. E. (1948, July, October). A mathematical theory of communication. *Bell System Technical Journal, 27,* 379-423, 623-656.

Sheppard, B., Janoske, M., & Liu, B. (2012). *Understanding risk communication theory: A guide for emergency managers and communicators. Report to Human Factors/Behavioral Sciences Division, Science and Technology Directorate, U.S. Department of Homeland Security*. College Park, MD: National Consortium for the Study of Terrorism and Responses to Terrorism based at the University of Maryland.

Shore, R. (2013). WHO | Lessons from Fukushima: Scientists need to communicate better, 396–397. Retrieved from http://www.who.int/bulletin/volumes/91/6/13-030613/en/index.html

Shouldis, W. (2013). Radio communications through C.A.R.D.S. *Fire Engineering*, *166*(3), 119-121. doi:10.1515/jhsem-2012-0083

Simon, T., Goldberg, A., Aharonson-Daniel, L., Leykin, D., & Adini, B. (2014). Twitter in the cross fire: The use of social media in the Westgate mall terror attack in Kenya. *PLoS ONE*, *9*(8). doi:10.1371/journal.pone.0104136

Snodgrass, J. (2014). Spirituality and homelessness: Implications for pastoral counseling. *Pastoral Psychology*, *63*, 307-317. doi:10.1007/s11089-013-0550-8

Stack, R. (2015). Unlocking interoperability: What it means for next-generation public safety communications. *Emergency Management*. Retrieved from http://www.emergencymgmt.com/next-gen-911/Unlocking-Interoperability-What-It-Means-for-Next-Generation-Public-Safety-Communications.html

Stănescu, A., Boeriu, C., & Copotoiu, S. (2016). Mass casualty incidents and disaster participation in real versus simulated events in Romania. *Acta Medica Marisiensis*, 62(1), 15-20. doi:10.1515/amma-2015-0092

Sun, L. G., Jones, A., & Nell, R. (2013). Disaggregating disasters. *UCLA Law Review*, *60*, 885-948. doi:10.1111/j.1467-8381.2012.02081.x

Timmons, R. P. (2006). *Radio interoperability: Addressing the real reasons we don't communicate well during emergencies*. Thesis. Naval Postgraduate Academy. Monterrey, CA.

Timmons, R. P. (2007). Interoperability: Stop blaming the radio. *Homeland Security Affairs*, web, n.p. February, 2007.

Tuite, D. (2012). Can public-safety radio's P25 survive LTE? *Electronic Design*, *60*(10), 44-50. Retrieved from http://electronicdesign.com/analog/can-public-safety-radio-s-p25-survive-lte

Verkuil, P. R., & Fountain, J. E. (2014). The Administrative Conference of the United States: Recommendations to advance cross-agency collaboration under the GPRA Modernization Act. *Public Administration Review,74*(1), 10-11. doi:10.1111/puar.12175

Visser, S. J., & Dawood, A. S. (2004). Real-time natural disasters detection and monitoring from Smart Earth Observation satellite. *Journal of Aerospace Engineering*, *17*(1), 10–19. doi:10.1061/(Asce)0893-1321(2004)17:1(10)

Wahyuni, D. (2012). The research design maze: Understanding paradigm, cases, methods and methodologies. *Journal of Applied Management Accounting Research*, *10*(1), 69-80. Retrieved from http://ssrn.com/abstract=2103082

Wang, Z., & Zlatanova. S. (2016). Multiagent based path planning for first responders among moving obstacles. *Computers, Environment and Urban Systems*, *56*, 48. [from Web source]

Weaver, W., & Shannon, C. E. (1963). *The mathematical theory of communication*. Champaign, IL: University of Illinois Press.

Wukich, C., & Mergel, I. (2015). Closing the citizen-government communication gap: Content, audience, and network analysis of government tweets. *Journal of Homeland Security & Emergency Management*, *12*, 707-735. doi:10.1515/jhsem-2014-0074

Yang, Y., Xiao, L., Cheng, H., Zhu, J., & Arbon, P. (2010). Chinese nurses' experience in the Wenchuan earthquake relief. *International Nursing Review*, *57*(2), 217-223 7p. doi:10.1111/j.1466-7657.2009.00795.x

Yin, R. K. (2014). *Case study research: Design and methods* (5th ed.). Thousand Oaks, CA: Sage.

Young, W. F., Matolak, D. W., Bikhazi, N., Holloway, C., Koepke, G., Fielitz, H., … Zhang, Q. (2013). Intra-volume, centralised array concept for improved public-safety communications. *IET Microwaves, Antennas & Propagation*, *7*, 916-925. Retrieved from http://ieeexplore.ieee.org

Zane, D. F., Jones, R., Huss, J., Sanches, K., Hoogheem, J., & Clements, B. (2012). Public health emergency response to a massive wildfire in Texas (2011). *Texas Public Health Journal*, *64*(4), 6-10. Retrieved from Academic Search Complete. Accession No. 83116165

Zhang, N., Huang, H., Su, B., Zhao, J., & Zhang, B. (2014). Information dissemination analysis of different media towards the application for disaster pre-warning. *PLoS ONE*, *9*(5). http://doi.org/10.1371/journal.pone.0098649